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BRITISH SPIDERS

THEIR HAUNTS AND HABITS

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BRITISH SPIDERS

THEIR HAUNTS AND HABITS

BY

THEODORE H. SAVORY

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PREFACE

THE general neglect of spiders in Britain is due in no small degree to the scarcity of books generally available for the purpose of their study. When Ellis's *Spiderland* (New York, 1912) was reviewed in this country, it was said that there was an opening for a similar book dealing with British species. No naturalist seems to have thought it worth his while to write one, and the statement remains as true to-day as it was a decade ago.

For our English spider-books can almost be counted on the fingers. Nothing is worthy of notice before Blackwall's *Spiders of Great Britain and Ireland* of 1861–3, a rare work, to be purchased sometimes for a five-pound note, and out of date. Miss Staveley's *British Spiders*, 1866, is still to be bought at a moderate price, but it is little more than a précis of Blackwall's monograph. Between 1879 and 1881 appeared the Rev. O. Pickard-Cambridge's *Spiders of Dorset*, which we who know it are accustomed lightly to describe as indispensable, as it indeed is, while we sometimes omit to add that it is also almost unobtainable.

Lastly, Mr. Cecil Warburton's *Spiders* in the Cambridge Manuals is an excellent introduction, and is in fact another 'indispensable', but it contains no descriptions of individuals.

In attempting partly to remedy this state of affairs, it seems valueless to undertake as yet the task of describing and portraying every species so far known to be British. One aims at arousing a general interest rather than, or at least before, producing a book of reference for the specialist, great as is the need, among the few specialists that there are, for such a work.

There is, among many people, an instinctive dislike of spiders which prevents them from ever taking any but an unkind view of these creatures, while others, who do not share this feeling, find it difficult to raise an enthusiasm for the study of a group of animals when there is so little literature to stimulate their interest. The aim, perhaps an ambitious one, of this book is to address itself to both of these classes.

A very real obstacle to both is the fact that, with a few possible exceptions, no spider has got a name in English, i.e. a nickname. They have binomial Latin names only. Writers sometimes try to avoid this by two methods. Either they translate the trivial name, and call *Agelena labyrinthica* 'The Labyrinth Spider', *Epeira diade-*

mata 'The Crowned Spider' and so forth, or they use this name alone and speak of *Labyrinthica* or *Diadematta*, or even 'Mrs. Diademata'. Both practices are objectionable and the last thoroughly repulsive. I have sufficient faith in the intelligence of my readers to ask them to realize that, in the circumstances, Latin names have to be used, and I have used them throughout in the normal way, asking pardon for the tiny effort that is required to become familiar with them.

Further, I have pointed out some of the gaps in our knowledge of the habits of spiders, and have made a few suggestions for readers who care to investigate these unknown aspects of natural history. I need hardly say what pleasure it would give me to extend and improve these for any one who is sufficiently interested to undertake this work and who will communicate with me.

T. H. S.

MALVERN,
April 1925.

'The work which seems to an outsider hopelessly petty and trivial may reveal the hidden forces of the Universe, or may afford means of dealing with the most pressing problems of mankind. The individual naturalist does not usually expect to attain any far-reaching results, but he knows that he is contributing to a structure of knowledge which, when reasonably complete, will begin to yield fruits of a kind that he may only dimly foresee. His faith is that the building will be serviceable, and all human experience goes to justify it.'—T. D. A. COCKERELL.

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PART I

I

INTRODUCTION

Atque ita, 'Vive quidem, pende tamen, improba,' dixit
'Lexque eadem poenae, ne sis secura futuri,
Dicta tuo generi, serisque nepotibus esto.'
Post ea, discedens, succis Hecateïdos herbae
Spargit, et extemplo tristi medicamine tactae
Defluxere comae, cumque his et naris, et auris;
Fitque caput minimum, totoque in corpore parva est;
In latere exiles digiti pro cruribus haerent;
Cetera venter habet: de quo tamen illa remittit
Stamen, et antiquas exercet aranea telas.

OVID, *Metamorphoses*, vi. 136–45.

IT is unfortunately impossible to ascribe to the spider any sort of economic importance whatever; unfortunate because a following of devotees intent upon determining the smallest detail of anatomy or the least iota of life-history is granted only to such as wage a definite war on behalf of, or more often against, mankind in general. Hence, as in the past when it was regarded with an unfounded dislike and an unreasoning fear, the spider is neglected to-day, the history of the study of spiders is a history of individual effort, and to the question, 'Are there thirty men in Great Britain who care anything for spiders?' the answer is, in all probability, 'No'.

The spider, then, has been the subject of the specialist:

to most men every spider is merely 'a spider', neither more nor less. This fact has never been more happily expressed than by the Rev. O. Pickard-Cambridge in his Introduction to the *Spiders of Dorset*. He quotes the remark of a friend who 'knew of *four kinds only*—the Red Spider, the Harvest Spider, the Garden Spider, and the House Spider'. There are over 540 different species of spiders at present recorded as British, and yet two of the creatures just mentioned are not spiders at all.

As we cast our minds back over the centuries, we find divers curious references to spiders in myth, science, and literature.

Quoted at the head of this chapter is Ovid's account of the legendary origin of spiders, the fate of Arachne; who for her temerity in supposing herself a seamstress comparable to Athena was turned by the irate goddess into the creature concerned, before all others, with the art of spinning.

Nowadays the only use of the spider to us is the old-fashioned method of stopping the bleeding of a cut finger by the application of a spider's web. The original prescription for this is to be found in a delightful treatise published in 1736 by one Eleazar Albin. He writes: 'The clean web of the house Spider, and dip it in the spawn of Frogs, beaten as you would the whites of eggs, several times letting it dry on pewter, or earthen plates, and keep it in a box close stopped from air, and apply it when you have occasion.'

Albin also had other ideas for the use of spiders' webs. For the 'cure of intermitting fevers', he prescribes—'As much of the clean web of the house spider as the weight of two scruples; Mithridate two drams; mix and give it

to the patient the night before the fit; let them take after it four ounces of treacle-water, and go to bed and cover themselves warm, endeavouring to sweat'. Nor was the spider itself altogether valueless. 'I have likewise', says Albin, 'cured several children, both male and female, by hanging a large Spider confined alive in a box about their neck, reaching to the pit of the stomach, without giving any internal remedies.'

A Dr. Watson, a contemporary of Albin, did not stop at external uses. His cure for fever was 'swallowing a Spider gently bruised and wrapped up in a raisin, or spread upon bread-and-butter'. Few, however, have appreciated the spider as an item of the menu. Rözel had a friend who used to spread spiders upon bread as a 'luscious substitute' for butter, and a lady known to Réaumur would eat them as fast as she could catch them. Lalande, the astronomer, used also to enjoy them, while from a German lady comes the information that their flavour resembles that of nuts.

The old belief that 'Spynners ben tokens of divynation, and of knowing what wether shall fal' dies hard among amateur meteorologists. That a spider should be seen to spin its web was taken as a forecast of a fine day, flimsy enough evidence, it would seem, on which to prophesy sunshine.

Ireland used to be supposed free from spiders. A poet, who, one can only imagine, had never been there, wrote:

> Happy Ierne, whose most wholesome air
> Poisons envenomed spiders, and forbids
> The baleful toad and viper from her shore.

This immunity was shared by Irish wood. In 1098

William II obtained, by license of Murchard, King of Ireland, the frames which made the roof of Westminster Hall, 'where no English spider webbeth or breedeth to this day', from the oak forest of Oxmantown, Dublin.[1] It is also said that spiders avoid the Irish oak in King's College Chapel, Cambridge.[2]

At Hambledon, in Hampshire, the parish church was roofed in 1334, with especial care, solely in chestnut wood, because it was believed that spiders avoided it.

But few, if any, of the adherents to these whimsies realized that the spider is a very wonderful creature, enclosing within its small body the most complicated anatomy and awe-inspiring instincts, by virtue of which it has become one of the most successful of living animals. The spider's life-history, *ab ovo usque ad mala*, is full of fascinating features and attractive biological problems, and those who study the despised spider soon realize the truth of Fabre's remark—'What is common is not necessarily insignificant'.

[1] See Meredith Hanmer's *Historie of Ireland*, 1633, and Goodman's *Fall of Man*, 1616.

[2] See Sir Thomas Browne's *Vulgar Errors*, xi. 7.

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II

THE LIFE OF THE SPIDER

'Life is one long struggle to get out of the way.'—H. H. B.

THE spider starts life as an egg, a diminutive spherical yellow body laid in a cocoon with a larger or smaller number of its brethren. From this egg there is produced in time a minute but perfect spider, differing from its parent only in size, and in being, at first, wholly enveloped in the cover of its egg and therefore unable to feed. The development is thus said to show no metamorphosis, or change of form, such as is familiar in the trio of stages, larva—pupa—imago, in the growth of an insect. The spiderling has to concern itself solely with increase in size, not alteration in shape.

The speed with which spiders' eggs develop is variable. Eggs that are laid in the autumn develop slowly all the winter, while those laid in the spring or summer hatch quickly. The little spiders break out of the egg-membrane while they are still together in the cocoon, then find their way out into the world and their life in the proper sense has begun.

All the habits of spiders that are confined to, and characteristic of, a single family are discussed in the second part of this book. In this chapter we are con-

cerned only with the more general aspects of their life-histories; that is to say, with their various solutions of the universal problems of protecting themselves, feeding themselves, and reproducing themselves, by such means as shall be best adapted to the environments they choose.

The first hint that a spider receives of the existence of these problems, comes as a rule from the overcrowding of its neighbourhood, following on the almost simultaneous liberation of a considerable number of its kind. It is well advised to begin by getting out of the way at once, and it does so in the ingenious way that has so often been described.

The spiderling's first action is to climb as high as possible, up a stalk of grass, perhaps, or to the top of a fence or railing, and, having come to the summit, to turn its head towards the breeze. Now it raises its abdomen as nearly perpendicular as possible, and secretes a drop of silk from its spinnerettes. This is drawn out by the slightest breath of wind into a streamer several feet in length. When a sufficient buoyancy is obtained, the spider lets go with all its legs and rises into the air, thus launching out upon a voyage which, be it for yards or miles, will carry it away from its home and help to spread its race.

Such is the explanation of the cause of 'gossamer', a phenomenon which has long attracted both naturalists and poets. The account of the great gossamer shower of 21st September 1741 given by Gilbert White in Letter LXV from Selborne will probably be well known to my readers. Another record of interest is that of Darwin, who mentions the embarking of many small spiders on the rigging of the *Beagle* on 1st November 1832, when

the ship was sixty miles from land. These spiders were very thirsty and eagerly sucked up drops of water.

In this way the little spider makes use for the first time of silk, a material that governs its whole life. It has been born into a silk nursery, and on a silk monoplane it flies away; with a silk web it catches its food, binding up with silk threads and ribbons its struggling prey or its bitter enemies. It drops from peril on a silk rope, of a silk sheet it makes its cocoon, its eggs are wrapped round with silk cushions. In a silk chamber it sleeps through the cold of winter, and even in death it is sometimes wrapped in a silk shroud. It is a remarkable biological fact that although the spider makes so many uses of this invaluable material, few other creatures can produce it, and none uses it to anything like the same extent.

The silk, like that of the silkworm, is a secretion formed in the glands as a viscous fluid. When expelled through the spinnerettes, it hardens into a thread, whose most remarkable property is its great elasticity. This may be seen by watching a web exposed to moderate winds, stretching and swinging without the least danger of breaking. Prof. Boys has shown that the tensile strength of these threads is second only to that of fused quartz fibres.

But man has never found many uses for spiders' silk. It was used for the cross-wires of telescopes and micrometers before the advent of substitutes, and Bennett used it in his famous experiment which, so fortunately for the acceptance of the undulatory theory, failed to detect the pressure of light.

The abundance of spiders compared with silkworms

almost demands the spinning of spiders' silk in the same way as that of the caterpillar, and, as long ago as 1710, a M. Bon, of Languedoc, made some silk stockings from this material. The Paris Académie des Sciences thereupon invited Réaumer to investigate the possibility of further use of spiders' silk, and his experiments conclusively proved that it was impracticable on a large scale. The cocoon silk alone is strong enough to be spun, yet a single thread of the silkworm is equivalent to four or five spider threads. The silk is so torn in the process of spinning that its lustre is much diminished, and the spiders must be kept separated from one another because of their cannibal natures. Further, Réaumur estimated that no less than 60,000 spiders would be required to produce a pound of silk, and the task of supplying such a multitude with food is an impossibility. Hence it is that the attempts to use spiders' silk have been very few, and we must return to the spider itself.

To provide itself with food is the primary instinctive action of every living creature, and it is in answer to this impulse that most of the spider's activities are directed.

With the sole exception of the larva of a Caddis, Hydropsyche, which lives under water, spiders are the only animals that construct a definite trap, their webs, for the purpose of ensnaring their prey, and to this peculiarity much of their biological success may doubtless be attributed. In, upon, beneath, or near the web rests the owner-builder, waiting for her prey to catch itself in the meshes, and making no efforts to increase the number of captives.

Whatever the form of the web, the theory of its use is the same. The spider, usually hidden, is in communica-

tion with it by threads on which its feet are resting, and the entanglement of a fly in any distant part is at once appreciated by the vibration of this thread. So delicate is the spider's sense of touch, that the slightest twinge of any thread by a passing insect is seldom unnoticed. If no further vibrations are felt, the spider will pluck at the threads, stimulating the captive, if such there be, to make a struggling attempt to escape. The repeated struggling serves only the more to entangle it, and the spider advances to investigate. If the capture is a body such as a piece of grass, which is of no use for food, it is removed from the viscous thread and cast out of the web.

The treatment of live victims varies with circumstances. Large and formidable creatures like wasps are usually cut loose, before their struggles destroy more of the web than they are worth. Small flies are seized at once and carried to the middle of the web or the spider's lurking-place, and sucked dry at once. Larger flies which show an inclination to kick about are trussed up in a band of multitudinous silk threads, so that they cannot move. It is a familiar and wonderful sight to watch the common garden spider winding this silk ribbon round a kicking fly. The fly is held in the first and second pairs of legs, and turned round and round with the help of the third legs and the palpi, while the tarsi of the fourth legs draw out bands of silk from the spinnerettes and cast it over the victim.

These poor mummies, often anaesthetized by the poison as well as bound in fetters, the spider carries off in comfort. They are sometimes consumed at once, and sometimes hung up thus to wait until they may more advantageously appear on the menu.

There are aspects of the poisoning powers of spiders which make the problem an interesting one. Undeniably spiders bite their prey and death follows, but debate interminable has raged around the danger of this poison to man. Few subjects unite such a wealth of literature with so completely contradictory results.

Many occasions have been recorded on which a spider's bite has been fatal to an animal many times larger than itself. My readers will probably be familiar with Fabre's account of his experiments with a captive Lycosa, whose bites killed a bird and a mole after an interval of some hours. Other examples are to be found in Darwin's *Voyage of the Beagle*, in E. J. Banfield's *Tropic Days*, and especially in Dr. McCook's *American Spiders and their Spinningwork*. There is no ground for denial of such facts as these. Foreign spiders frequently encounter formidable antagonists and prove a match for them.

The belief that spiders are poisonous to man arises from the legend of the Tarantula,[1] a notorious inhabitant of south Europe. Taranto is a town which was founded by Greeks expelled from Sparta for the taint of illegitimacy, and the present inhabitants still speak a patois which retains traces of Greek. It was apparently in this town that the malady of tarantism arose. As is well known, the supposed consequences of the spider's bite were a general lassitude or melancholy, which ultimately proved fatal if a cure were not effected in time. The sole cure was music. Those bitten, the tarantati, summoned a

[1] But the name Tarantula has long been loosely applied by travellers to any large spider in every country.

musician, who played before them a variety of airs, or tarantellas, until he hit upon one that inspired the patient to dance. We cannot refrain from quoting this description:[1] 'They touched, at length, some chord supposed to vibrate to her heart; and up she sprung, with a hideous yell, staggered about the room like a drunken person, holding a handkerchief in both hands, raising them alternately, and moving in very true time. As the music grew brisker, her motions quickened, and she skipped about with great vigour and variety of steps, every now and then shrieking very loud.' Such activity was supposed to cure the disease because the poison was worked out of the system in perspiration.

It is extraordinary that such a fable should receive acceptance, more especially as its truth has been denied, first in our *Philosophical Transactions* for 1672, and often since, and also because a reasonable explanation of the fraud is possible.

The tarantati adorn themselves, and behave, in a manner which too closely resembles the fashions of the priestesses of Bacchus to leave any doubt as to the origin of tarantism. When the introduction of Christianity put a stop to the public exhibition of heathen rites, the Bacchantes continued their profitable trade, but were obliged to offer some irrelevant explanation. Evidently the local spider best supplied their needs.

But the Tarantula is a special instance, where we are concerned with the general problem. This embraces widely separated extremes, the limit being probably expressed by one Scaliger of Gascony, who says that

[1] From Gmelin's *Natural History*.

there were, in his country, 'spiders of that virulency that, if a man tread upon them, to crush them, their poison will pass through the very soles of his shoes'.

Almost every author of a book on spiders has recorded that a spider's bite produced upon himself no effect, or, at the most, a slight irritation, while travellers' tales have brought from abroad the most remarkable accounts of bites followed by insensibility or great inflammation. But there is never one reasonably authenticated in which a spider was, without any doubt, the cause of the trouble. The danger of the spider's bite is a myth.

The spider's meals are followed by growth. As this proceeds, the exoskeleton outside the body grows tighter and tighter until it must be shed, and a new one elaborated.

This process of ecdysis is a great business. For some days before it is due the spider stops eating and its legs become darker in colour until they are almost black. At the critical moment the spider suspends itself upside down, and, by wriggling, splits the skin round the edge of the cephalothorax and along the under side of the abdomen. The carapace and sternum thus fall away and the soft skin of the abdomen quickly shrivels off.

Now the most serious part of the work begins, the extraction of the legs and palpi from their old skins. This old skin does not split, so that the legs have to be slowly and simultaneously pulled out. To do this the spider gives a series of heaves, each of which reminds one of a human yawn, and moves the leg through a scarcely perceptible distance. A large house spider that moulted under my own observation heaved fourteen times a minute for half an hour, and then for ten minutes seventeen

times a minute. This gives a total of nearly 600 pulls to extract a leg some 30 mm. long. A smaller spider can moult completely in twenty minutes.

Legs, palpi, and chelicerae, when first extracted, are soft and quite a pale green in colour, only assuming their normal shades after several hours. Moulting is quite a serious affair for the spider, which runs some risk of losing limbs or life in the process. The cast skins are thrown aside by the spider, and, in the outskirts of a cob-web which has been long inhabited, several are often to be found. Mr. Warburton, in his happiest vein, thus comments on these: 'It is not unlikely that the reader has mistaken these casts for the shrivelled forms of unlucky spiders, and has had his sympathies aroused, or has experienced a grim satisfaction, in consequence—an expenditure of emotion which this account may enable him to economize in future.'

Besides allowing for growth, this act of ecdysis is associated with the process of regeneration or the re-appearance of lost limbs. If a young spider loses a leg, or even two or more, these limbs grow again beneath the exoskeleton and at the time of moulting become visible and useful. If the loss of the limb occurs soon before ecdysis is due, a vestige only may be produced, but at the next moult a larger limb results. In any case, it is always possible that more than one moult may be required to produce a perfect limb, and it may be that maturity is reached first. The spider must then be content with an undersized leg.

The full value of this ability to reproduce lost parts is seen only when considered in connexion with the spider's power of voluntarily throwing off a limb, when its life

may be saved by such a sacrifice. Such autotomy, which the spider shares with most other arthropoda, is usually first recognized by the collector. Many a spider has escaped from one who, with fingers or forceps, has caught it by a leg and who now retains his hold upon that leg alone! Autotomy is naturally more frequent with immature spiders, which do not suffer a permanent loss. It is a definite voluntary act and not a forcible rending asunder of the tissues, as may be seen by holding a spider by one leg. The other seven strain against one's hand and the liberation follows a quite obvious jerk. A spider held by two legs cannot, or at any rate does not, free itself in this way.

Spiders are preyed upon by birds, frogs, and in fact any animal whose diet normally includes insects, for they are not rejected on the score of taxonomic differences. In addition, they have more special enemies of their own. Two species of Ichneumon flies parasitize the cocoons of spiders, the Ichneumon laying its eggs in the cocoon and the grubs, on hatching, feeding on all the eggs of the spider. Later in life, four different species are known to lay eggs in the abdomen of the spider itself, on which the caterpillar feeds until the death of its host results. Some members of the Aceroceridae, a family of Diptera, also pass their larval stages in the cocoons or bodies of spiders, which they consume before pupation.

Wasps are deadly enemies of spiders. Of the three families of Fossores, or Solitary Wasps, one, the Pompiliidae makes spiders its especial prey; and several members of a second family, the Sphegidae, will also attack them. These wasps, by a wonderful instinct, sting the spiders in a nerve ganglion, so as to paralyse them and

prevent them from struggling, while also keeping them alive. The wasp then lays an egg in the body of the spider, which may be sealed up in a cell or left where it lies, and the larva that hatches is supplied with plenty of fresh food.

American wasps of the genus *Pepsis* can overcome *Mygale avicularis* or *M. hentzii*, which are among the largest known spiders. These wasps usually attack their victims when they are away from their burrows or knocked off their webs, when they offer only a feeble resistance.

However terrible all these risks to the spider may sound, Nature always provides so large a number of eggs that a certain number, probably averaging two per cocoon, will reach maturity after a life that amounts to nothing less than a continuous series of escapes from sudden death. The spider, not once, but all the time, has had to get out of the way.

Generally speaking, the spider's solution of this problem is a passive one—it tries not to be seen, or, if seen, it tries to look like a dead spider or something that is not a spider at all. There is none of the striking mimetic species among the common spiders of this country, but a very superficial acquaintance with them is enough to make it clear that in form and colour a general resemblance to their surroundings exists.

Often, however, camouflage does not provide good enough concealment. Then most spiders adopt the scheme of feigning death, drawing in their legs and falling motionless. If they fall from a web, they retain communication with it by falling on a thread, so that they can climb back again when the danger has passed.

The common garden spider and many others will illustrate the habit at once.

W. H. Hudson in *The Naturalist on La Plata* describes a most interesting observation of this habit. There were, in the bushes of one region, two spiders, one green, the colour of a fresh leaf, the other yellowish-white, the colour of a leaf faded and dried. When these spiders were startled out of their webs, the green one fell fairly quickly, and the brown one with a slower motion, as though it were as light as a withered-up leaf.

When mature, the spider shoulders the responsibility that invariably attaches to that estate. If it is a male, it soon ceases to spin webs, and, forsaking a stay-at-home life, yields to the Wanderlust in search of a mate. How he manages, in all the vast universe, to meet the object of his desires, is a mystery. It is possible that the stridulation, mentioned later, may be of some service; it may be that he relies on his own activity and pure chance. According to his family, the female may be encountered hunting on the ground or resting in her web. In the former case, there are seldom either risks or preliminaries, except for some of the Salticidae, whose remarkable performances are referred to later.

When a spider arrives on the outskirts of the web of a mature female of his own species, he seems to be instinctively aware of her presence, and his first act is to test her temper. This he does by drumming on the web with his palpi, producing a vibratory disturbance which the female is evidently able to distinguish from the arrival of a fly. This drumming of the palpi has also been seen among wolf spiders, which drum on the dead leaves over which they are running, and among trap-door

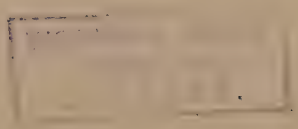
spiders which knock on the door of their mate's burrow.

The female spider is often disinclined for wooing, and this seems to be particularly true of the common garden spider, *Epeira diadematа*. In such circumstances she advances threateningly towards the male, who must either retire or risk and probably lose his life in mortal combat with a larger and heavier spouse. This remarkable feature of a spider's mating has so appealed to the popular mind that many believe it to be a universal fact that the female eats the male. This is by no means true. Of several species the two sexes live together for a longer or shorter time in perfect harmony, and in August the exceedingly common webs of both *Linyphia triangularis* and *Agelena labyrinthica* are often found inhabited by the blissful pair. Among other spiders, the male may unconcernedly leave the female and either die or seek another, for, besides monogamy, both polygamy and polyandry occur in the spiders' society.

When the spider becomes a mother, she usually takes care that the duties of motherhood do not become a burden. The great majority of spiders lay their eggs in cocoons with varying amounts of protective covering, and when these are completed, take no further care of them. These are, generally speaking, the spiders whose lives last only from spring to winter ; the production of their cocoon is the climax of their lives, and after the effort they soon die of old age. There are, indeed, exceptional instances of spiders that do take a personal interest both in their cocoons and in the young ones that hatch therefrom ; these will be described in the following chapters.

There are, too, many spiders that survive the winters

and live for some years. Very little information is available on the subject of longevity, and it is of necessity limited to those species that live peaceably in cages. The record seems to be held by two female *Tegenaria derhamii*, which lived with a Dr. Oliver in Bradford, one for five, the other for seven years. It should, however, be remembered that these spiders were not in their natural environment, but in much more favourable circumstances.



III

SPIDERS' INSTINCT AND SENSES

> The spider's touch, how exquisitely fine,
> Feels at each thread, and lives along the line.
>
> A. POPE.

IT has always been realized that instinct is difficult to define. Professor Romanes described instinctive actions as conscious acts that are adaptive in character but are pursued without necessary knowledge of the relation between the means employed and the end attained, and although this implies much of the essential character of instinct, it is still incomplete. It is, in fact, impossible to find, for so complicated a phenomenon, a nice definition in a few words.

Although this verbal difficulty besets the thoughtful biologist, it does not sufficiently concern the practical 'naturalist'. Instinct is hard, maybe impossible, to define, but instinctive actions are easy to recognize. When once they are recognized, admiration and wonderment must follow, often with lamentable results. Instinct comes to be regarded as the infallible, perfect, and delightfully incomprehensible 'cause' of every action. Looseness of thought can be screened by the use of a word of partially understood meaning, or by mere prettiness of phrasing, so that a veritable fairy story may be con-

structed, which will charm all the readers whom it does not unendurably irritate.

This apotheosis of instinct is the more modern tendency. In the eighteenth and nineteenth centuries, naturalists boldly ascribed all such actions to intelligence, and described them with unhesitating zest. They made the fundamental error of interpreting every action of the animal from a purely human point of view, with the result that the animal was credited with motives, emotions, and knowledge, for which there was no real evidence. It is essential to steer a path between these two extremes.

Most of the actions of a spider are purely instinctive, which implies that, although they may contribute to individual experience, they can be carried out perfectly on their first performance in the absence of experience, and further that they are adaptive to the well-being of the individual and of the species.[1] These instinctive actions depend on the inherited structure of the nervous system, and not on the inheritance of intelligently acquired habits. Hence it is not justifiable to describe the spider that shams dead as 'cunning', neither is the spider that eats her husband 'cruel', nor the spinner of the orb-web 'clever'.

That the degree of intelligence exhibited by spiders is of a primitive order is readily seen by following this line of thought a little farther. Intelligent actions demand acquired characteristics in the nervous system, the result of the relation of the individual to its environment.

For example, a spider in the corner of its web is stimulated to rush out and attack an enmeshed insect by the

[1] Other features of instinctive behaviour, necessary for its complete diagnosis, are here omitted, as being less applicable to the spider.

vibrations of the silk threads. It will attack a tuning-fork that is used to shake its web in the same way and for a certain time. Each time that the spider runs out to the fork it is performing an instinctive action, but so soon as it refrains from running out it is exhibiting intelligence. If it were capable of instinctive actions only, it should continue to run out indefinitely as often as the fork shook the web, but in its capacity to learn it shows itself, to that extent, intelligent.

Besides the capacity to learn, intelligence must usually imply the ability to remember. A spider, however, will after a quarter of an hour attack the fork again. It is clear that, if the previous incident of the fork had impressed itself too strongly on the spider, it might never again run out to capture food, until it had somehow learnt to distinguish between fork and insect.

This 'educability' is, in general, a measure of the extent of a creature's intelligence. The instance of Darwin's pike is too familiar to be cited here, and that of the Peckhams' *Cyclosa conica* may take its place. This spider is an orb-spinner which, like many others, drops from its web at the sound of a vibrating tuning-fork. Mr. and Mrs. Peckham endeavoured to teach the spider that no ill effects followed on the sound, and that dropping was unnecessary. For a month the spider was tested daily and invariably dropped. On the 20th July it fell nine times and then took no further notice of the sound, and until the 5th August dropped five, six, or seven times daily. On that day nine notes from the fork did not move it, and during the rest of the experiment the spider retained its imperturbability.

Except for such a slight power of intelligence, a spider's

life is entirely conducted by instinct, ignorant, blind, and selfish. Its migration, its web-spinning and cocoon-building, its feeding, its mating, and its care of its young are performed in response to a series of internal impulses which the creature is, in general, quite powerless to modify for the purpose of meeting altered circumstances.

The whole study of spiders emphasizes this aspect of their instinctive actions: the spider's response to the internal impulse is so irresistible, so irrational, so blindly mechanical, that of altered circumstances it takes no heed whatever.

Fabre has shown that the nightly web-spinning of an *Epeira* is such an action. If, on its completion, he cut the web in halves, the spider remained on the valueless wreck and showed no inclination to spin another web. A wolf spider accustomed to live in a hole of its own excavation was shown, also by Fabre, to possess no instinct to dig a second hole, if dragged away from its first. The operation of cocoon-spinning is carried out in its entirety, even if the eggs are removed as soon as they are laid, and hours of work are expended on a valueless shell.

As we have seen, the educated spider which has profited by experience shows that it has done so by modifying its behaviour. In common parlance, it improves with practice. Profit drawn from individual experience affords evidence, but the only evidence we possess, of the existence of an inward consciousness of the experience itself.

In its common act of spinning a web, a spider, from birth to death, shows no sign of profiting by experience. It never spins more quickly, or more symmetrically, or in a series of better and better chosen places. It never

improves. Therefore web-spinning may be an unconscious act, an act that makes no contribution to individual experience, and thus affords no data by which the individual spider can profit. It may seem a startling idea to suppose that a spider is all the while unconscious of the complex co-ordinated actions which it performs in spinning a web, but, while we have no evidence of such consciousness, we have familiar evidence of the unconsciousness. It is a common cause for wonderment that spiders should spin webs in such absurd places as the inside of a sealed museum case; even more absurdly in the small cages in which they can be kept and from which they have found escape impossible. It is difficult to interpret such acts if they are supposed to be conscious.

We therefore conclude, that although the results of a spider's actions are extraordinarily wonderful, the actions themselves are not dictated by skill or sense as we human beings understand it, but by a series of instinctive directions that almost pass human understanding.

Let us turn to the development of the various senses in spiders, and consider their ability to see, hear, smell, taste, and feel.

A spider's eyesight is a curious matter. An elaborate provision of eight eyes of different types should surely argue a considerable power of vision, and yet, in the lives of all spiders that spin webs, sight plays a very small part and is often exceedingly feeble. One has but to observe the behaviour of captive spiders to be assured of the fact that to the vibrations of the web alone does the spider owe knowledge of its prey's approach. Often the fly walks up to the spider and stands in front of it, yet

no movement of the latter shows that it is aware of the fly's presence. It therefore does not seem as though their eyes were of much value to these spiders, but there may be exceptions. No less an observer than the Rev. O. Pickard-Cambridge has recorded of a *Meta segmentata*: 'I have more than once seen one drop, not from fear, but upon an insect which it had espied on the ground a little way below it, ascending again quickly with its prize, by means of the lines drawn from its spinners in the descent.' Probably the most useful function of the eyes to most of these spiders is to inform them of the approach of dusk and of dawn, and to enable them to carry out many of their tasks under cover of darkness.

The sight of hunting spiders is very different. The eyes are much larger, and the spider must invariably see its prey before it can attempt to catch it. Some members of the family of Jumping Spiders have been seen to recognize their mates at a distance of 10 or 12 inches.

In this connexion, we must finally quote the following,[1] one of the best 'yarns' about spiders that it has ever been our good fortune to meet.

'Un brave pêcheur consacrait tous ses moments de loisir à fabriquer lui-même les mouches qu'il employait pour pêcher la truite. Une après-midi, il avait réussi à faire trois mouches parfaites. Tout content de son travail, il va chercher sa pipe pour payer une bonne bouffarde et se récompenser de ses peines. A son retour, les mouches qu'il avait laissé sur la table avaient disparu. Il regarde partout, cherche et aperçoit une araignée qui s'en était emparée et les entraînait vers son trou. J'oubliais de dire que le fait se passe en Amérique.'

The belief that the spider is fond of music is many

[1] *Le Chasseur Français* (St. Etienne), Numero 340 (1913), pp. 602-3.

centuries old. Spiders have been said to appear from their hiding-places at the beginning of a concert and to return thither at the end. They have been described as coming nightly to stand on or listen to a piano or harmonium that was regularly played, and we may, according to our natures, be disposed to believe or to disbelieve these legends without further question. We may, however, feel assured that the habits of an animal express its solution of the triple problem of protecting, feeding, and reproducing itself, and that in consequence, if any of these activities depends on one sense particularly, that sense is certain to be well developed; while if a sense is not used, it is at least probable that it may gradually cease to exist. Thus we might well suppose the spider to be deaf, and to be happy in deafness, were it not that its occasional actions seem to point to an ability to hear.

If a vibrating tuning-fork be brought near a spider which is hanging in the middle of its web, one of two things may happen. The spider may drop on a thread and lie feigning death on the ground, or the fore-legs may be raised and held out horizontally. If the first pair of legs be missing, the legs of the second pair are held out. In any case the spider has clearly been able to appreciate the sound-waves from the fork, and the same reaction is provoked by a cry, a hoarse cough, or the bark of a dog.

On the other hand, before such a spider a naturalist once noticed varied responses to the notes of a flute, but found that the same results followed a noiseless puff of air. With hunting spiders there is generally no response to sounds whatever. The spider is apparently deaf; grass-

hoppers have sung for hours beside a starving spider which has paid no heed to them.

Further, we are bound to consider the acoustics of the response of the web-spider. It hangs in the middle of a system of stretched silk threads, threads of various lengths and various tensions, and no arrangement could be more likely to vibrate by resonance to any note. Is it remarkable that a spider thereon should be disturbed? A body on the wires of a grand piano jumps like a live thing.

If a spider can hear, where are its ears? Research has so far failed to find with certainty this baffling detail of anatomy. It is possible that some of the bristles and spines on the spider's legs may act as auditory organs. Certainly many of them are very delicate organs of touch, and it is probable that they can feel the vibratory movement of the air in much the same way as a deaf person may be aware of the sounding of the Bourdon stop of an organ. If this be so, we cannot say that the spider hears. To hear must imply an interpretation of the sound heard, resulting in appropriate action. The spider's reaction to sound is apparently valueless to itself.

It is curious that the response to scents consists of the same action, the spider raising its legs and sometimes rubbing them together. At the far end of each of the first six joints of the legs is found a series of minute chitinous ridges, which have been christened the lyriform organs. These were at first thought to be auditory organs, but it is now generally accepted that they are really olfactory.

The sense of taste is usually associated with that of smell, but there does not seem to be any evidence that

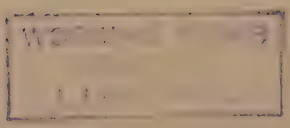
the spider can distinguish the taste of its food. Certainly captive spiders will feed on anything.

The whole of the spider's life is evident proof of the wonderful development of its sense of touch. The sense organs are the hairs and spines with which the palpi and legs are always freely covered, and so delicate are these that among sedentary spiders the sense of sight is almost superseded by that of touch. Even in hunting spiders, which have good eyesight, this sense is well developed.

Finally, we must in this chapter consider the power of stridulation which some spiders possess. Many animals can produce a noise not by their throats but by the rubbing together of two roughened surfaces. The song of the grasshopper and cricket is the most familiar instance, and several families of foreign spiders possess stridulating organs on their legs or their palpi, by means of which they can produce sounds. Among British spiders the family of Theridiidae possess such a structure, the stridulation being produced by rubbing the abdomen on the hind surface of the cephalothorax, just above the pedicle. The sound produced is inaudible to human ears and is produced only by the males, the organ being rudimentary or missing in the female. Its purpose may be sexual attraction, or it may serve as a warning to certain enemies, or both. No British spider has, however, been proved to produce an audible note.

A curious action of male spiders, and, I believe, of male spiders only, is a sharp twitching of the abdomen, jerking it down on to the web. No silk can be seen to be secreted, and a male spider on the web of a female does it whenever it stops moving, but seldom more than once at a time. The habit was recorded as long ago as 1883,

by an observer who described it as a sign of impatience. It must, however, surely possess a physiological rather than a psychological significance. Even if such a mental state were possible to a spider, it is hardly likely that an animal whose life is spent largely in awaiting the chance blundering of a fly into its web could retain such a characteristic. Indeed, it seems no more likely that a spider could be impatient than that it could be amused or love-sick. We cannot, however, by any means get inside the spider's mind ; in this, and in all other such problems, the final court of appeal must remain, as with Aristotle of old, the judgement of the educated man.



IV

SPIDERS IN CAPTIVITY

In this wild groping, dank and drearie cove,
Of wife, of children, and of health bereft,
I hailed thee, friendly spider! who has wove
Thy mazy net on yonder mouldering raft:
Would that the cleanlie housemaid's foot had left
Thee tarrying here, nor took thy life away;
For thou, from out this sere old ceiling's cleft
Came down each morn to hede my plaintive lay
Joying, like me, to heare sweete musick play,
Wherewith I'd fein beguile the dull, dark, lingering day.

RECORDS of companionship like that described above are rare in history, but not altogether absent. Pélison, for example, during his imprisonment in the Bastille, found comfort in a spider which he so tamed that it would come to its food at the sound of music. Another Frenchman is recorded by Kirby and Spence to have tamed and fed eight hundred spiders.

He is, therefore, not without a certain precedent who essays to keep spiders in captivity, and speedily he finds them to be curiously attractive pets. One remembers with regard to the pets of one's childhood, the worries of leaving them at home to the care of sisters or similar substitutes. The spider's solution of this problem is uniquely simple—it requires no care. It does not need fresh air or exercise; its cage does not want cleaning, the spider itself need not even be fed.

Of course, all species of spiders do not live in captivity

with the same equanimity. To keep wolf spiders or jumping spiders in a cage is a matter of very considerable difficulty ; a garden spider, the inhabitant of the

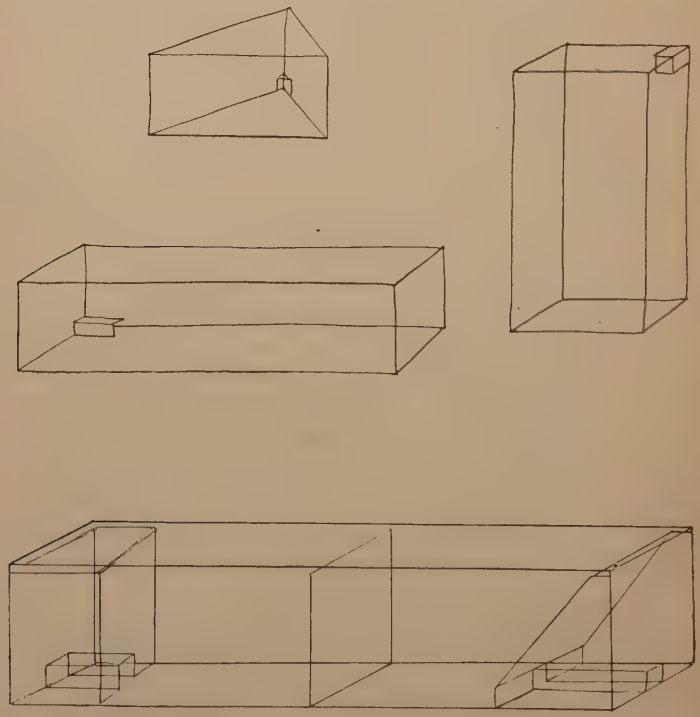


Fig. 1. Spiders' Cages.

circular web, demands quite an elaborate and spacious cage before it will consent to spin a normal web. But with a little care and originality in cage-construction representatives of most genera can be induced to live happily.

The house spider, the spinner of the cob-web, takes most kindly to captivity, but even this species is influenced to some degree by the form of the cage. A *Tegenaria* in a plain glass-covered box is not one tithe so comfortable as one in a box with a little shed or shelter in one corner. This corner, which is slightly the darkest, it employs for the tube-shaped part of its web.

The spider will begin a web as soon as it is satisfied that escape is impossible. The spinning is a gradual process, carried out by slow degrees, so that the outlines are just visible by the second day, and in six months there is a sheet of silk almost opaque and nearly as strong as muslin.

By the second or third day the spider can catch the flies with which we supply it. It need hardly be pointed out that the fly must be admitted to the cage alive, since the spider is warned of its presence only by its struggles in the web, and not by sight, sound, or scent. I have seen a fly walk up to within half an inch of a spider and the two stand staring into one another's eyes, motionless.

Frequently the capture of the fly takes place in three distinct stages. First the fly, wandering over the cage, gives one thread of the web a twinge with its leg or wing. Instantly the spider is on the alert, and comes some way out from its shed in the direction of the disturbance. The fly, however, seems always to be aware of its peril, and the second stage sees both spider and fly remaining perfectly still, waiting. This cannot last long. A spider is born and bred to patience, as a fly is most certainly not, and so the fly moves again. Then the spider rushes out and, in all probability, subsequent operations interest the fly no more.

A spider's web is, in fact, an extension of the organs of touch. When the spider is waiting for an insect to shake the web again, it may be seen to be pulling on the sheet of silk as a fisherman keeps a feel of his line. Sometimes the spider by gently drawing in its front legs gives a slight shake to the web, which is exactly what is wanted to stimulate a fly to move again.

It is a noteworthy fact that the spider very frequently bites the fly in the thorax. As often as not the spider, in its first rush, secures a leg of its victim, and it invariably follows this up by biting it in the thorax. I have even seen a spider which had pounced upon a large bluebottle definitely turn the struggling insect over and bite it in the thorax from beneath. And a spider which I have seen attack a Yellow Underwing, approaching the moth from behind, contented itself with holding down the wings with its legs until it was in a position to bite it in the thorax.

The common house spider will usually let a wasp force its way out of the web, although sometimes it attacks wasps boldly and conquers in the fight. It does not produce a winding sheet, as does the garden spider, but it adopts an interesting modification of the process by which it brings about the same result. Holding the struggling insect in its jaws, it presses it down on to the sheet of its web, and, by walking round in circles, twists it up in a sufficient tangle of silk to limit its struggles very successfully.

The meal that follows consists solely of suction of the liquid contents of the insect, after which the dried carcase is carried off to a distant corner. J. H. Fabre, in his description of *Agelena labyrinthica*, tells us that on feeding

it with locusts 'the bite is usually given at the lower end of a haunch: not that this place is more vulnerable than any other thin-skinned part, but probably because it has a better flavour. The different webs which I inspect to study the food in the larder show me, among other joints, various flies and small butterflies and carcases of almost untouched locusts, all deprived of their hind-legs, or at least of one.'

Corresponding to this, it is therefore of considerable interest occasionally to see a house spider, after throwing away the dried carcase of a blue-bottle, pick up severally the detached legs that were lying in the tube of its web and suck them, as if they were, as Fabre suggests, 'a dainty, the equivalent, on a very small scale, of the larger legs of the crayfish'.

A remarkable fact about a captive spider's meals is that there is practically nothing that a spider will not eat. All kinds of flies and Daddy-long-legs, bees, wasps, ants, earwigs, beetles, moths, butterflies, woodlice, harvestmen, and other spiders are all treated alike, caterpillars are consumed entirely: chrysalides, worms, and even small fish are bitten and sucked for what they are worth. Raw meat and the ends of young feathers have also been used by some—there is no sort of discrimination.

In times of scarcity, no flying creature able to provide a drop of sustenance seems to be rejected. A garden spider that once lived for some weeks under my observation in a tool-shed used to accept and try and find nutriment in the carcases of Daddy-long-legs that had died during the winter before. Professor Vernon Boys, in making experiments on the response of Epeirae to the shaking of their webs by a vibrating tuning-fork, found that if he placed

in the web a dead fly that had been drowned in paraffin and touched it with the vibrating fork, the spider would seize it and devour it, ignoring the oil with which it was soaked. In times of plenty, however, the spider will show daintiness, and take only a small meal from each fly before casting out its carcase.

The spinning of a web is the only effort which a web-spider makes towards obtaining its food. So precarious a supply as this would seem to be, dependent solely upon the kindness of Chance, must inevitably produce periods of disappointment. A fast, however, seems to be but a slight inconvenience to a spider.

I invariably left captive spiders in their cages in my rooms in Cambridge at the end of each term, and never found a dead spider on coming up again some six or eight weeks later. Blackwall, in his *Researches in Zoology*, describes how he caught a *Theridion quadripunctatum* (i.e. *Steatodea bipunctata*) in August 1829. He fed it until 15th October, when it was corked up in a phial and locked up in a bookcase. It did not die until 30th April 1831, having fasted for more than twenty months.[1]

These facts seem to be even more remarkable when it is found that a spider possesses a capacity for food which approaches gluttony. I have seen a spider start eating a fly when simply bloated by the consumption of a second spider originally as large as itself. Darwin has related

[1] Other creatures can surpass this. For example, the Rev. A. H. Cooke collected examples of the mollusc *Helix desertorum* in Egypt in 1904 and kept them in a tin box without food. In January 1912 ten individuals were still alive, but only three survived by the following March, although food had been supplied to them.

how he found a small *Theridion* which had captured a large wasp.

'Pitying the wasp, after allowing it to struggle for more than an hour, I killed it and put it back into the web. The spider soon returned, and an hour afterwards I was much surprised to find its jaws buried in the orifice through which the sting is protruded by the living wasp. I drove the spider away two or three times, but for the next twenty-four hours I always found it again sucking at the same place. The spider became much distended by the juices of its prey, which was many times larger than itself.'

Although normally the opportunities for such excesses do not occur frequently, captive spiders tend to be overfed, and overfeeding is not without effect. A house spider that I caught in early April 1914 was the object of attentions from a large number of friends. She laid her first cocoon of eggs on 4th May, and then rested for thirty-six days before laying the second on 9th June. Thereafter she produced ten more cocoons at almost regular intervals of a fortnight, and ultimately exceeded by five months her natural expectation of life.

One of my most pleasing experiences with captive spiders was concerned with food. A cage contained a pair of Agelenae which, in spite of popular opinion, were living together peaceably enough. I put a fly into the cage and the female, which was much the bolder and more active, caught it by the leg. Her husband now rushed up, a *mêlée* followed, and the fly escaped. The lady, however, soon caught it again, and, in the hope of preventing a struggle which might prove fatal, I admitted a second fly to attract the attention of the male. He scorned, however, any provision of a potential meal in preference to one prepared. He approached the female,

who had the fly by its thorax, and buried his jaws in its abdomen. Thus they remained imperturbable, the two spiders sharing the same fly, until the meal was finished.

After a meal a spider may often be seen 'cleaning its teeth'. It brushes its palpi over the front of its chelicerae and continues the operation for some minutes, cleansing with especial care the angle between paturon and opened unguis, and also the space between the two paturons, all the while opening and shutting both parts of the chelicerae and moving them backwards and forwards.

An exceedingly interesting extension of this process may be seen after a spider has been running, as many are quite well able to do, on the surface of water. The second and third pairs of legs are dried by pulling them slowly through the opening and shutting chelicerae, and finishing by sucking off the water from the tarsus. The palpi are dried in the same way. The first and fourth pairs of legs are cleaned a little by this method, but mainly by rubbing carefully with the second and third pairs. The sternum and abdomen are dried by rubbing with the metatarsus and tarsus of a leg. These separate actions do not take place in any orderly fashion: a little of one is followed by a little of another, and often two are simultaneous. The spider dodges from side to side and from limb to limb without sequence, and the whole operation may take half an hour.

Nearly all captive spiders exhibit a certain individual character. Mature females are usually the best behaved, for their webs are spun in normal form, maintained in good repair, and the cage is kept tidy. I have seen a little heap of corpses accumulate in one corner, while the rest of the cage was quite clean. It is the same with

the faeces: eighty per cent. of these are dropped right into the corners, and another fifteen per cent. close to the sides, the middle of the cage being comparatively clear.

Male spiders are quite different. Naturally, perhaps, in their more peripatetic character, they do not take so kindly to domestication, although their behaviour is fair before maturity. Thereafter no silk is added to their webs, which rapidly fall into ruin, while their cages generally are untidy. A mature male spider placed in a new cage makes either a very poor attempt at a web or none at all.

One is tempted to include in a third category the character of very young spiders. These small creatures need an almost gas-tight cage to meet successfully their migratory instincts and their ability to squeeze themselves through the narrowest crack. The delicate webs they produce are almost invisible, but they will entrap small flies and gnats, in attacking which the spiderling has not the slightest hesitation. The insect may be two or three times as big as the spider, but the latter clings to it so firmly as to allow itself for a while to be carried bodily round the cage.

It is often difficult to find food for these tiny spiders, a problem which is but partially solved by employing their brothers from the next cocoon; but I have known them to survive the winter on no more than a few drops of water. They will also eagerly suck up a drop of beer.

The cocoon spinning of captive spiders closely related to ordinary house spiders is a lengthy process made familiar by the excellent description given by Mr. War-

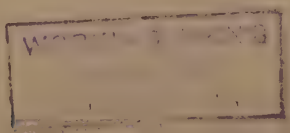
burton. The cocoon is nearly always made during the night, and the sign of preparation is the spinning of a small sheet of closely woven silk, upon the lower surface of which the eggs are deposited. They are then covered with more silk, the cocoon rounded off by a long and elaborate series of activities, and finally the cocoon is protected by plastering its outside with small pieces of stone or anything of that sort.

House spiders in captivity often spin abnormal cocoons. Sometimes they lay the eggs in the day, when the whole process may be watched without the sacrifice of a night's rest.

I have known one spider spin the preparatory sheet, and subsequently make no attempt to lay the eggs and finish the cocoon—in fact it was obviously not the possessor of any eggs at the time when the sheet was spun. Another spider got as far as laying the eggs, but no farther; she made no attempt to cover or protect them at all, and so enabled me to secure a unique photograph of a spider's egg-cocoon in the middle of construction.

Mr. Warburton tells how the spider will finish its cocoon if the eggs be removed as soon as they are laid. A house spider showed me the same blind instinct on an occasion when the eggs fell from the sheet to the floor of the cage. The cocoon was then finished as if nothing had happened.

Keeping spiders in cages, like white mice or canaries, may sound, to some, like the act of a lunatic: it is, perhaps, a little too reminiscent of Dracula. But, in point of fact, the hobby is one of quite unceasing interest. The more it is adopted, the more rapidly will our very small knowledge of the habits of spiders be increased.



V [1]

THE ANATOMY OF SPIDERS

Nature, that gaue the bee so feate a grace
To finde hony of so wondrous fashion,
Hath taught the Spider, out of the same place,
To fetch Poyson by straunge alteracion.

WYATT.

A SPIDER viewed from above shows plainly its chief characteristic, that the body is divided into two regions by a very slender 'waist'. This waist is properly called the pedicle, and in some families it is protected by upper and lower plates or sclerites of chitin, known as the lorum and plagula respectively. There is no neck, so that the head and thorax are fused into one, forming a cephalothorax, but in many species the original distinction between the two is visible in the form of a cervical groove. The region posterior to the pedicle is the abdomen.

On the forepart of the cephalothorax are situated the eyes, usually eight in number, occasionally six, and rarely four or two, but four-eyed spiders are never found in Britain. They are simple ocelli, quite unlike the compound faceted eyes of insects. Their arrangement on the cephalothorax forms a guide of great value to the systematist. They are disposed in two rows, sometimes straight but more

[1] This chapter, which is a trifle technical, is intended for students of zoology. The scientific terms used are explained in the Glossary.

often curved, either backwards or forwards. The curvature may be so great as to give an appearance of three or four rows, and the eyes themselves, by their situation,

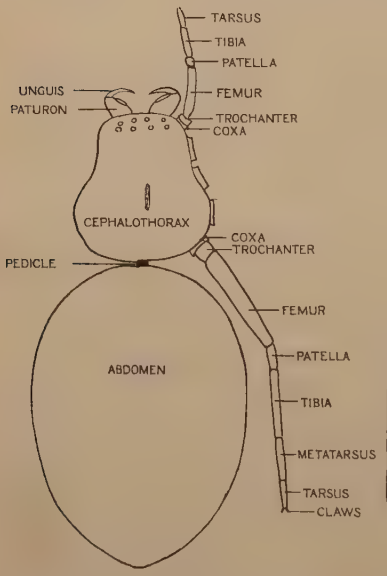


Fig. 2. A Spider: dorsal surface.

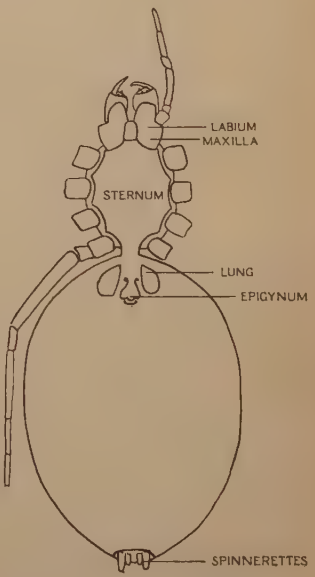


Fig. 3. A Spider: ventral surface.

which is either oblique or on small projections, may embrace a wide field of vision.

Many investigations have shown that spiders' eyes have a complicated structure, but have left us in comparative ignorance of the value of these eyes to their owner, which is, after all, the most interesting feature of their study.

The lens of the eye is a transparent portion of the

ordinary exoskeleton, and is shed with it at the time of moulting, when the spider is temporarily blind. In some families of spiders the eyes are obviously of different types, usually described as diurnal and nocturnal. The former appear black, the latter pearly white. This is due to the presence beneath the retina of a reflecting surface, or tapetum. The tapetum reflects the light

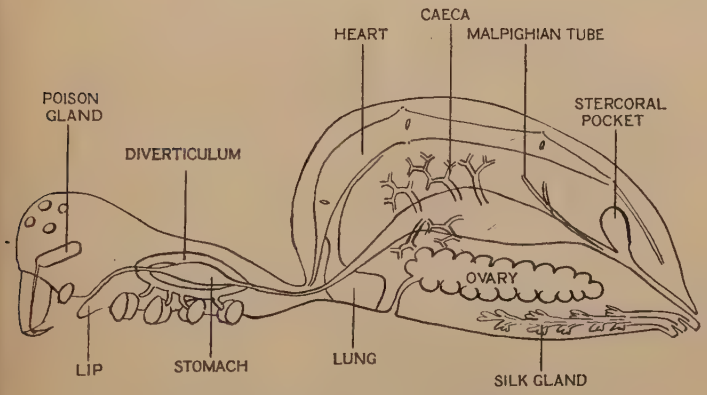


Fig. 4. A Spider : vertical section.

which has entered the eye, so that it passes a second time through the retinal cells, and thus increases the visibility of objects in a dull light. A tapetum exists in the eyes of cats and many moths, whose eyes 'shine in the dark' in a familiar way. It is this reflection that makes the nocturnal eyes of spiders appear paler than the diurnal.[1] The anterior median eyes are never nocturnal.

[1] But some nocturnal eyes appear to be diurnal, owing to a layer of pigment cells in front of the retina ; conversely some diurnal eyes show a pearly lustre for some other reason than the possession of a tapetum.

In front of the eyes, the bases of the poison fangs or chelicerae are seen. These appendages, which are often called mandibles, though not homologous with the mandibles of insects, are two-jointed and unchelate. Various names have been given to these joints; we prefer Lyonnet's terms, unguis and paturon. The ungues are

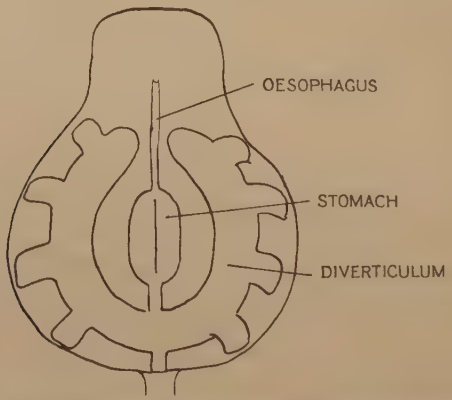


Fig. 5. A Spider's Cephalothorax: horizontal section.

sharp, sickle-like joints, with the orifices of the poison-ducts at their tips. The paturons are stout and hollow, enclosing the poison-duct, and furnished on the inner sides with one row or two rows of teeth. In trap-door spiders, Mygalomorphae, the chelicerae strike vertically downwards, acting parallel to each other; in all other spiders they strike transversely, towards each other, with only a slight freedom longitudinally. In one family of spiders only, the Pholcidae, the unguis meets a small projection on the paturon, forming a chelate organ. The poison glands are situated in the front of the cephalo-

thorax, except in the Mygalomorphae, in which they are found in the paturon. The glands are sac-like structures, secreting and storing the poison which escapes through the duct already mentioned.

To the cephalothorax are attached the eight legs and a pair of palpi. The palpi are six-jointed, the joints being coxa, trochanter, femur, patella, tibia, and tarsus. In the female spider the tarsal joint ends in a claw, and the limb is a purely sensory one. In the mature male the tarsus acquires a most complicated structure, and is an accessory to the reproductive system.

The legs are seven-jointed, each consisting of a coxa, trochanter, femur, patella, tibia, metatarsus, and tarsus. The coxae are usually just visible, projecting beyond the edges of the cephalothorax, in the dorsal aspect. The tarsus bears two, or, in some families, three pectinated claws; the third claw when present being a smaller median one. In addition to these claws the Epeiridae possess supplementary serrate hairs, and the Salticidae and some others have beneath the claws a small tuft of hairs known as the scopula. Both legs and palpi are in all spiders covered more or less plentifully with hairs, bristles, and spines. Some of the hairs are feather-like, and are sometimes erectile. They are almost certainly tactile in function, and some of them have also been thought to be auditory.

The actions of walking can be analysed in spiders which have been wearied by much running, and which move so slowly that their movements can be easily watched. The longest legs, those of the first and fourth pairs, move along the lines of their own directions by vertical bending of the joints; the shorter legs of the

second and third pairs move forwards by rotation from the coxae, at right angles to their own directions.

The	first	near	leg	moves	with	the	fourth	off	leg	(*a*)
„	second	„	„	„	„	„	third	„		(*b*)
„	third	„	„	„	„	„	second	„		(*c*)
„	fourth	„	„	„	„	„	first	„		(*d*)

Walking consists of (*a*) and (*c*) simultaneously, followed by (*b*) and (*d*) simultaneously.

In the middle of the cephalothorax there is usually a small depression. This is caused by the attachment inside of the muscular walls of the 'sucking stomach', and has been called the median fovea.

From underneath the outward structure of the spider presents much more detail. The palpi are seen to arise from the sides of the maxillae, between which lies the lip or labium, forming the lower surface of the mouth. The shapes of the maxillae and lip are, again, valuable taxonomic features. Beneath the cephalothorax is the sternum, usually oval or heart-shaped, having sometimes a number of small prominences opposite the eight coxae.

The most conspicuous features on the lower surface of the abdomen are two whitish patches close to the waist. These are the lungs: between them is the epigyne, or the opening of the oviduct.

The epigyne of the mature female spider is the best, and often the only certain, way of determining the species.

It would be almost impossible, in any single dissection, to display even a fair proportion of the internal organs of a spider, but by combining the results of several dissections in diagrammatic horizontal and vertical sections,

much of the structure and the relationships of the different systems may be illustrated. For purposes of description we may take the systems in turn.

Within the cephalothorax is the chief internal skeletal structure. This is a plate of chitin, known as the endosternite, providing attachment for certain muscles and support for various organs.

The alimentary system of spiders is divisible into three portions, a fore-gut or stomodaeum, a mid-gut or mesenteron, and a hind-gut or proctodaeum. The system opens at the mouth, an orifice which for some time defied discovery. In fact, Lyonnet almost concluded that it did not exist, and that the food was absorbed through the fangs of the chelicerae.

To find the mouth, the spider must be placed upside down and the labium raised. There will then be found accompanying the labium a thick piece of tissue, the rostrum, which forms the upper surface of the mouth, while the labium forms the lower surface. The lower side of the rostrum is marked with a longitudinal groove which when opposed to the labium forms the pharynx. The fluids which constitute the food of the spider rise up this pharynx, probably by the action of surface tension or capillarity, and pass along the oesophagus into the so-called 'sucking stomach'. This is a hollow organ, fixed by muscles to the endosternite beneath and to the tergum of the cephalothorax above, in the region of the median fovea. By the contraction of these muscles its size can be altered, and a sucking action thus applied at the mouth. In these regions the stomodaeum is lined with a chitinous invagination or internal continuation of the exoskeleton, and the food undergoes no alteration.

The process of digestion in all creatures is a chemical alteration of the foodstuffs in such a way as to render them soluble and able to pass through the intestinal walls into the blood and lymph streams. In the spider digestion starts in the mesenteron. The mid-gut passes from the stomach backwards towards the waist, but before reaching this constriction it gives off two forwardly directed arms or diverticula which lie in the cephalothorax on each side of the stomach and above the endosternite. Each diverticulum has four short lateral prolongations in the directions of the four legs, while in some families the diverticula meet in front, forming a complete circle.

In different creatures we find different methods of ensuring as complete an absorption of the food as possible. In mammals such as ourselves the small intestine or ileum is much elongated ; in the worm, whose alimentary canal is a straight tube, there is the dorsal fold or typhlosole which increases its surface ; in the dogfishes and sharks the food makes its way down the winding stair of the spiral valve. Spiders show a remarkable elaboration of the mesenteron to ensure a large absorptive area, of which the diverticula in the cephalothorax form a part. It seems to be uncertain whether or not the food meets a digestive or solvent fluid secreted by the walls of these diverticula.

The mesenteron passes back through the pedicle or waist into the abdomen, soon after entering which it widens for a short distance. From this wider region other narrow diverticula are given off, which branch in a bewildering and complicated fashion around the intestine and often round the heart as well. These masses of

tubules were at first described as being a digestive gland and were vaguely termed the 'liver'. Later the impression gained ground that they were probably more closely allied to the pancreas of vertebrates, but it is now generally accepted that the food passes to the extreme ends of these branching diverticula.

There is an obvious confirmation of the truth of this idea in the appearance of a spider after a large meal. The abdomen becomes enormously bloated, showing that it is distended with food. It would be clearly impossible for the central canal of the mesenteron to expand to this extent, and it would be contrary to all experience to find the food entering the liver or the pancreas during digestion. The food must enter the diverticula and be absorbed from them into the blood by which they are surrounded.

The mesenteron passes into the proctodaeum without sensible change except that the latter is, like the stomodaeum, lined with chitin. On the dorsal surface of the proctodaeum is a hollow, the stercoral pocket, into which open the Malpighian tubules. These tubules are an excretory system, familiar to most of us as existing in insects, and the excreta seem to be retained in the intervals between evacuation in the stercoral pocket. In this pocket the faeces also collect. The alimentary canal terminates at the anus, which opens medially behind the posterior pair of spinnerettes.

The abdomen also contains the respiratory system and most of the vascular system.

The heart is a tubular organ lying dorsal to the alimentary canal, sometimes close to the skin and sometimes deeper and buried in the diverticula mentioned

above. It is enclosed in an envelope, the pericardium, with which it communicates by three pairs of lateral openings or ostia. These ostia have each a valve which allows blood to pass through them into the heart, but prevents blood from escaping from the heart. The number of arteries from the heart depends on the number of lung-books which the spider possesses. The Mygalomorphae, which have four lung-books, have ten arteries; the majority of spiders have eight arteries. These eight are a caudal artery to the posterior regions, three pairs of abdominal arteries, and a forward dorsal aorta.

The dorsal aorta passes through the pedicle and divides into two branches, which lie at the sides of the sucking stomach. Anteriorly these branches unite again, giving off the mandibular artery to the chelicerae and various other smaller branches.

The absence of capillaries and the fact that all the organs are actually bathed in blood are characteristics of the 'open' blood system of the Arthropoda. The body cavity is not of the nature of a coelom, but is a haemocoel, the true coelom being banished to inconspicuous hollows in the genital and excretory systems. Correlated with this there is a system of blood sinuses instead of veins. The blood is collected in three sinuses in the cephalothorax and three sinuses in the abdomen, which deliver it to the lung-books, whence it is returned to the pericardium. The blood is colourless and contains a number of colourless amoeboid corpuscles.

There is in all spiders a dual respiratory system. The position of the lung-books, organs which American authors call book-lungs, has already been noted. Some spiders possess two of these organs, but in some families

there are four. These organs are invaginated hollow chambers, communicating with the air by small orifices. Within they contain the delicate plate-like leaves to which they owe their name. The leaves are attached anteriorly and laterally, where their hollows are in continuity with a blood sinus, and are free posteriorly. The blood flows into them, and is aerated by diffusion of the oxygen through their delicate walls. Each chamber contains from fifteen to twenty leaves, and the two chambers are always in communication by spiracles.

In addition to the lung-books, all spiders possess tracheae. In front of the spinnerettes, on the lower surface of the abdomen, is the median or paired opening of the tracheal system, an orifice which is small and very hard to discern. The tracheae are always paired, even when they open at a median aperture. They give off smaller branches among the abdominal viscera, and resemble in structure and appearance the tracheae of insects.

The nervous system of spiders is considerably modified from the typical arthropodan arrangement. During development there are several ganglia in the cephalothorax, but as it proceeds a coagulation or cephalization of these ganglia takes place. The adult system consists of a 'brain' or pre-oesophageal ganglion in front of the oesophagus, giving off nerves to the eyes and chelicerae, and in close connexion with a post-oesophageal ganglion. This ganglion is the origin of nerves to the palpi and legs, and from it run two nerve cords along the lower surface of the cephalothorax. These unite to form an unimpaired median nerve cord along the floor of the abdomen. Such is the simple appearance of this system ;

within it hide the mysteries of the spider's life—its actions, its senses, and its extraordinary instincts.

The reproductive system of spiders is fairly simple. The testes of the male lie in the abdomen below the intestine, and from each of them a coiled vas deferens

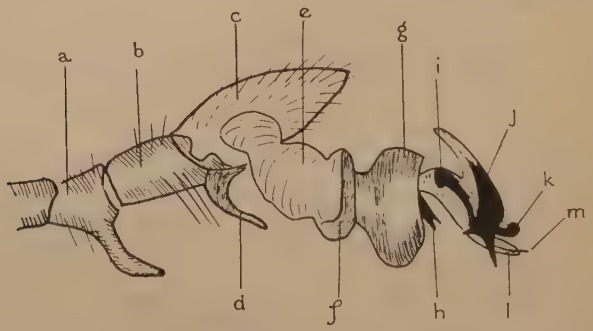


Fig. 6. Palpal Organ of a Male Linyphia.

a patella.
b tibia.
c cymbium.
d paracymbium.
e basal haematodocha.
f subtegulum.
g tegulum.
h median apophysis.
i radix.
j lateral subterminal apophysis.
k terminal apophysis.
l conductor.
m embolus.

leads to a minute orifice in the epigastric furrow between the lung-books. The spermatozoa are liberated here, either on to a leaf or on to a specially spun web, and are taken up by the palpi before coition.

In their simplest form the male palpi consist of a 'genital bulb' at or near the end of the tarsus, the genital bulb itself being a seminal reservoir, with a projecting ejaculatory duct. The greatest possible elaborations of this organ are, however, found in the different

genera, in many of which it is an exceedingly complicated structure (Fig. 6).

In such complex palpi the genital bulb has left the extreme end of the tarsus and lies farther back on the inner side, in a hollow, the alveolus. The cup-like tarsus is rechristened the cymbium. The genital bulb is divisible into three portions, basal, middle, and apical. The basal portion consists of a haematodocha or soft-walled sac which at the time of pairing is distended with blood. This division contains the fundus of the receptaculum seminis, and is covered by the sub-tegulum. The middle division, covered by the tegulum, contains the reservoir of the receptaculum seminis. The apical division consists of two structures. The embolus, within which runs the ejaculatory duct and which is sometimes composed of two joints, radix and stipes, is usually the more conspicuous, and near it is the conductor, whose essential function is to protect the tip of the embolus in the unexpanded bulb.

In addition to these parts there are nearly always several projections or apophyses, as well as secondary haematodochas, which together compose this remarkable organ. Its numerous variations form a valuable means of characterizing the males of every species.

The ovaries of the female, covered with ovarian follicles, appear like two clusters of grapes. Sometimes their posterior ends are united, producing a ring-like ovary. The ova, when mature, pass into the coelomic hollow in the middle of the ovary, and thence along the oviducts and vagina to the exterior. The spermatozoa which fertilize them are, at the time of sexual union, driven into the vagina from the receptaculum seminis of the male

palp by a rush of blood to the haematodocha. The sperm are then stored in the spermathecae until they are required, so that a female spider can lay several cocoons of fertile eggs after a single copulation. The spermathecae are either diverticula of the vagina, or they may

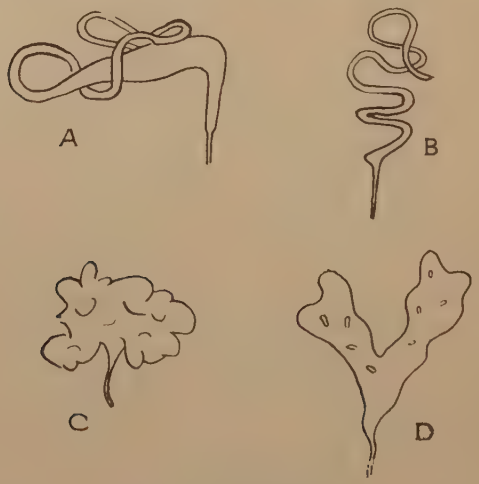


Fig. 7. Silk Glands.

A Ampullaceal. B Cylindrical.
C Lobed. D Aggregate.

have separate openings and be connected to the vagina by a duct. They vary in number and are provided with a gland; this gland is usually the dark spot visible through the skin of the spider.

The silk glands of spiders are, as might be supposed of a creature that owes its name, its food, and its life to their function, of considerable complexity. There are

found no less than seven different sorts of silk-producing glands, and these are:

1. The Aciniform glands.
2. The Pyriform glands.
3. The Ampullaceal glands.
4. The Cylindrical glands.
5. The Aggregate glands.
6. The Lobed glands.
7. The glands of the cribellum.

No spider possesses all seven glands. The first three glands are found in all spiders, and the cylindrical glands in the females of all save the Dysderidae and Salticidae. The aggregate glands are confined to the Epeiridae, Linyphiidae, and Theridiidae; the lobed glands occur only in the Theridiidae; while the cribellum glands are only associated with the possession of that organ.

These glands open on the spinnerettes which are situated at the posterior end of the abdomen. Spinnerettes are normally six in number; they are finger-like processes, covered with hairs and provided with a large number of minute tubules, known as spools or fusulae, and two or more larger tubes, known as spigots.

Normally each spinnerette possesses about one hundred spools and the anterior pair carry one spigot each, the median pair three spigots each, and the posterior pair five spigots each.

The spools have two uses. They provide the 'attachment disk' which anchors every spider's thread at each end; these disks are made by the anterior spinnerettes supplied by the pyriform glands. The spools of the middle and posterior spinnerettes, supplied by the aciniform glands, emit the swathing band or broad ribbon of silk with which the spider often enshrouds its victims. The lobed glands of the Theridiidae also produce

a swathing band from a spigot or two on each hind spinnerette.

The ampullaceal glands supply the spigot on each fore-spinnerette and one on each middle spinnerette. The fore-spinnerettes are the ones most frequently used. The foundation lines of the web, and the drag-line which is usually laid down wherever a spider goes, proceed from them. It follows that these lines are double, and can be divided into two at any point in their length. When occasionally extra strength is requisite, the line is quadrupled by the action of the ampullaceal spigots on the middle spinnerettes.

The remaining two spigots on each of these middle spinnerettes, together with two of the five spigots on each of the hind spinnerettes, are used only in the making of the cocoon. They are connected with the cylindrical glands, whose secretion is often coloured and is placed round the egg sac, probably as a protection from cold. Three spigots on each posterior spinnerette remain: these do not produce silk, but through them is poured, from the aggregate glands, the viscous fluid which forms drops on the spiral lines of the web.

Liphistius, a primitive spider from Sumatra, has eight spinnerettes, and there are several families of spiders which have an additional spinning organ. This is the cribellum, a sieve-like plate, through the holes of which silk exudes and is combed out by the legs of the fourth pair. To this end the metatarsi of these legs bear a comb of curved bristles, the calamistrum.

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VI

THE CLASSIFICATION OF SPIDERS

All sorts are here that all the Earth yields,
Variety without end.

Paradise Lost, vii. 541.

It cannot be denied that to many readers the subject of the classification of spiders is bound to seem a dull one, while to those without previous acquaintance with biology it may even be appallingly difficult. It is certainly true that it is going to demand the use of polysyllabic Latin names and an insistence on unfamiliar details of structure, both of which apparently repel certain classes of readers.

Why then should this chapter be included at all? For two reasons: first, because some, perhaps, will appreciate the value of the subject for its own sake, but chiefly because it forms an essential introduction to the second part of the book. There is no use in our reading about house spiders, wolf spiders, crab spiders and the rest, unless we can also distinguish these families from one another. Moreover, the chapter shall be made as simple as possible.

The huge phylum in the animal kingdom known as Arthropoda is divisible into five[1] classes, Crustacea,

[1] Authorities differ considerably about this number.

Antennata (including Myriapoda and Insecta), Arachnida and two others of small importance. Arachnida was the name given in 1815 by Lamarck to a class which was to include spiders, scorpions, and mites, animals which had previously been described as apterous insects. The differences between the three great classes may be tabulated thus:

CRUSTACEA.	ANTENNATA.	ARACHNIDA.
Generally aquatic.	Generally aerial.	Generally terrestrial.
Two pairs of antennae.	One pair of antennae.	No antennae.
Breathe by gills.	Breathe by tracheae.	Breathe by lungs and tracheae.

Spiders, therefore, are *not* insects! Besides the above differences, their body is divided into cephalothorax and abdomen, while the insect is divided into head, thorax, and abdomen. Spiders have eight simple eyes, insects usually have two compound ones; insects have six legs and hatch as larvae, spiders have eight legs and hatch as small spiders.

The class Arachnida is divided into some fifteen[1] orders, only four of which contain creatures which are familiar to most of us. These are the Scorpionidae, or the scorpions, the Opiliones, or harvestmen, the Acari, or mites and ticks, and the Araneae or Araneida, the true spiders. Araneida, strictly speaking, means 'like the genus *Araneus* or *Aranea*'. The genus *Epeira* is sometimes called *Aranea*, but *Epeira* is preferable and Araneae should therefore be adopted as the name of the order.

[1] By E. Ray Lankester, vide *Encycl. Brit.*, article Arachnida.

The characteristics that separate the Araneae from their near relatives are very clear. Scorpions have the poisonous claw at the end of the abdomen; harvestmen, mites, and ticks have no narrow waist separating the thoracic and abdominal portions; spiders alone have a soft unsegmented abdomen which is furnished with silk glands and spinnerettes. We are now in a position to examine the spiders themselves more closely.

The order Araneae is unequally split into three sub-orders.[1] One of these includes a single family of curious primitive forms, unknown outside the tropics. The second includes all trap-door spiders, of which but two are found, rarely, in Great Britain, while in the third are the vast majority of all living spiders.

This last sub-order is divided into many [2] families, of which twenty-two have representatives living in Britain. It is seldom a difficult matter to decide to which of these twenty-two a given spider belongs. A microscope or strong magnifying-glass may be necessary for the determination of some of the finer structural features, but, apart from the slight trouble involved by this method of examination, there are few obstacles to be surmounted. It is the division of the families into genera and species that is the cause of most bewilderment to students, and of most of the differences of opinion among authorities.

Spiders are most easily examined lying in spirit in a clean white saucer. The one-inch objective provides a sufficient magnification for all except the smallest; occasionally the half-inch may be used with advantage.

[1] Called Liphistiomorphae, Mygalomorphae, and Arachnomorphae.

[2] Fifty-six. By Prof. A. Petrunkevitch, *Ann. N. Y. Acad. Sci.*, xxix, 1923, 145–80.

The spider must of course be illuminated with a bull's eye condenser, and may be supported in the desired position by a small pad of cotton wool, which also helps the illumination. In order to fix the family of a British spider, one must examine:

(i) the number of its eyes,
(ii) the spinnerettes and the tarsi of the fourth legs,
(iii) the claws on its tarsi,
(iv) other details about eyes or legs.

All these points are clearly set out in the table below. It is self-explanatory, but it must be remembered that it is applicable to the British species only.

TABLE FOR THE SEPARATION OF BRITISH SPIDERS INTO FAMILIES

A. With four lung-books, and the chelicerae acting vertically and downwards. ATYPIDAE.
AA. With two lung-books, and the chelicerae acting transversely and inwards.
B. With six eyes (or two).
C. Eyes in three well separated pairs. SCYTODIDAE.
CC. Eyes in a compact group.
D. Eyes large and oval. OONOPIDAE.
DD. Eyes moderate and round, or nearly so. DYSDERIDAE.
BB. With eight eyes.
C. Cribellum and calamistrum present.
D. Anterior median eyes dark, others pearly white.
E. Tarsi with a row of spines. AMAUROBIIDAE.
EE. Tarsi without spines. DICTYNIDAE.
DD. All eyes dark.
E. Cribellum divided; eyes in two quadrangles. ERESIDAE.
EE. Cribellum entire; eyes in two curved rows. ULOBORIDAE.
CC. Cribellum and calamistrum absent.

D. Tarsi with two claws.
E. Legs laterigrade, first and second pairs strong.
F. Posterior eyes curved with convexity forwards, i. e. 'recurved'; fourth legs longest. SPARASSIDAE.
FF. Posterior eyes curved with convexity backwards, i. e. 'procurved'; first or second legs longest. THOMISDAE.
EE. Legs more equal and prograde.
F. Eyes in three rows, anterior median eyes largest. SALTICIDAE.
FF. Eyes in two curved rows.
G. Fore-spinnerettes widely separated; maxillae with oblique impression near middle. GNAPHOSIDAE.
GG. Fore-spinnerettes contiguous; maxillae straight. CLUBIONIDAE.

DD. Tarsi with three claws.
E. Eyes in three or four rows, black and unequal in size.
F. Eyes in four rows, anteriors smallest; legs with long spines, only fourth trochanters notched. OXYOPIDAE.
FF. Eyes in three rows, 4, 2, 2.
G. Legs of normal length; all trochanters with deep semicircular notch on distal border of lower side.
H. Female carries cocoon in chelicerae; second row of eyes much shorter than third. PISAURIDAE.
HH. Female carries cocoon at spinnerettes; second row of eyes only slightly shorter than third. LYCOSIDAE.
GG. Legs extraordinarily long and slender; abdomen long and cylindrical. PHOLCIDAE.
EE. Eyes in two rows, not very unequal in size.
F. Superior spinnerettes long and two-jointed (except the water spider).
G. All spinnerettes in a group. AGELENIDAE.
GG. Spinnerettes in a transverse line. HAHNIIDAE.
FF. All spinnerettes one-jointed, in a compact group.
G. First and second legs with a series of long spines, with small spines between them, on the tibiae and metatarsi. MIMETIDAE.
GG. No such spines.

H. Fourth legs with a double row of short spines beneath tarsi; rest of legs without stout spines. THERIDIIDAE.

HH. Tarsi without such spines, legs with stout spines.

I. Maxillae widest at base. LINYPHIIDAE.

II. Maxillae widest at tip. EPEIRIDAE.

Figures illustrating many of the above structural characters will be found in the following chapters, where the twenty-three families are described.

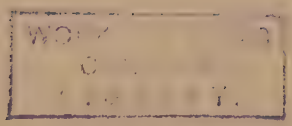
In these chapters, mention is made of the commoner genera and species, and tables, similar to the above, for the separation of the genera, have been added. It is hoped that these tables will be of interest to some, and of value to collectors of spiders. The distinguishing features of all the genera of British spiders are not, at present, published in a compact and readily available list. Until this is so, the use of the tables in this book may be of assistance to students of British spiders in helping them to overcome a very real initial obstacle.

The tables have been compiled from Mons. E. Simon's *Histoire Naturelle des Araignées*, with occasional references to Mr. W. Falconer's *Keys to the Families and Genera of British Spiders* and some other sources. So far as the genera are concerned, they may be considered fairly trustworthy. The list of species should, however, be accepted with some caution. No list of British spiders has been printed since 1902, and, as will readily be understood, there is some difficulty in collating the various, scattered, more or less inaccessible, and not always even published statements of opinion by those whom we acknowledge as authorities.

It must also be realized that, in using these tables, the

determination of a genus should invariably be confirmed afterwards, using the more detailed diagnoses published in the *Histoire Naturelle* and elsewhere.

With regard to species, the present position is such that the majority of collectors will be using the descriptions printed in E. F. Staveley's little book, which is still readily obtainable, while both Blackwall's and Pickard-Cambridge's are scarce. The value of this book, which is a précis of Blackwall's, is enormously greater if the present names of the species it describes be known. I have, therefore, where possible, added these names, as foot-notes, to the tables of genera in the following chapters. This makes it possible to use Staveley's, or Blackwall's, description of species in conjunction with the more recent separation into genera which I have given here.



PART II

WORKING MEN'S
COLLEGE

VII

HOUSE SPIDERS

(THE FAMILY AGELENIDAE)

It is to be regretted that several spiders are so thoughtless as to try to share our houses, for these are the culprits chiefly to blame for the general unpopularity of the whole order. If we can overcome the prejudice against this minority, or even get it reconsidered, we shall have performed no small service to the spiders of England. It is for this reason that house spiders have been chosen for the first chapter of this part of this book.

Of several genera that might lay claim to be considered as house spiders, the one that most deserves the name is the genus *Tegenaria*, which belongs to the family Agelenidae. The family, however, includes other genera, which do not naturally live in houses.

Every one who has taken books from a shelf or a picture from a nail has noticed the 'cobwebs' behind them, dusty and dilapidated remains of the homes of small spiders These were *Tegenaria derhamii*, the most widely spread and one of the most numerous of all the spiders in the temperate zone. It is purely a dweller in houses, and is seldom or never found in the open, but it lives in every house, shed, stable, or garage in Britain. It is scarcely less common all over Europe and in the United States of America.

This spider is 11 mm. long. Its cephalothorax is a reddish-brown, with black lateral bands. Its abdomen is a yellowy brown with a series of triangular black spots along the middle and rounder black spots on the sides. The femora of the male are a very dark brown.

Its web, when it is spun in a less cramped space than those mentioned above, is a triangular sheet of silk with its innermost corner shaped into a short tube, but without any other sort of shelter. As a web it may be distinguished from that of other spiders of this family by an overhead rope which usually runs outwards from this tubular retreat and meets the farther edge of the sheet.

All the members of the family make webs of this type—a tube connected to a sheet, the spider living in the tube and hunting on the sheet. The latter varies in shape and extent according to circumstances.

It must not be thought that webs of this type, which often attain a very large size indeed, are produced in the same rapid way as the familiar orb-web of the garden spiders.

On the first evening after its arrival at a new site, the house spider walks round its domain and lays down a few threads of silk, the limits and scaffolds of the building to come. Nightly thereafter, and at odd times, the spider wanders over these threads, and, as it does so, one may notice its long spinnerettes diverged in action, its abdomen carried with a curious swaying motion, broadcasting silk. Thus the web grows gradually by accretion; it never reaches a point at which the owner can say 'Hold, enough!'; always it gets thicker and stronger as long as the owner lives in it.

Thus are repairs effected. The web suffers in the

chase, holes and rents appear on the surface. The spider has no instinct that teaches it how to put a patch over a torn place. As we have already seen, its powers are so limited that it cannot pick up a process in the middle and perform a fraction of it. This disability is overcome by the habit of desultorily spinning, of adding silk when an opportunity occurs.

The efficiency of such a method can be tested by choosing a tenanted web and poking a hole in it with a pencil. Slowly, very slowly, threads appear, crossing the gap, half a dozen in number, perhaps, within twenty-four hours. In a week there is no hole, but its place is marked by the lighter, cleaner silk, contrasting with its older dustier surroundings. A 'wild' and not a caged spider must therefore be used for this experiment. The web, when free from dust, as are captives' webs, retains indefinitely its glistening whiteness. A cobweb is really only dirty because it hangs in a dirty place, the house of a man. It no more deserves censure for its dirty appearance than does a coal-miner or a sweep.

When the spider is at home it stands in the tube, sometimes, if alert, facing outwards, at others quiescent, facing inwards. At the least twinge given to the web by a blundering fly it is all alive, runs out to the source of the disturbance, and if possible grips the intruder in its jaws and carries it into the corner.

This species is an interesting one to tease with a tuning-fork. If the sheet of the web be lightly touched with the vibrating prong, the spider, quite unable to distinguish between the shaking produced by a fly and that produced by a fork, will run rapidly out and attack the metallic stranger. Then, disgusted at its discovery, it

hurries home and turns its back on the deceiver. But its memory of the deception is short, for half a minute later it will run out to the fork again. It will repeat this action many times until its continuance wearies the body and perhaps educates the mind.

Often in the autumn evenings we are surprised, and perhaps startled, by the sudden appearance of a large long-legged spider, that scurries across the carpet as it makes a dash from one cover to another. This fearsome creature is another *Tegenaria*, only a little less common than *T. derhamii*, and known as *T. atrica*. With but two exceptions it is the largest of all English spiders: its body is 19 mm. long, carrying four immense and hairy legs, of which the longest—the first pair of the male—are 50 mm. in length. Its cephalothorax is a rich brown, with black lateral bands; its abdomen bears a khaki stripe down the middle, into which run several pairs of lateral marks of the same colour, whose farther ends are broadened. The abdominal pattern is completed with other brown and black spots. The sternum has black borders, with a brown spot opposite each leg.

This spider is widely spread in England, and the specimens from Devon and Cornwall are often larger than those found farther north. In suitable places their webs may become immense; I have seen them, spun between the parallel rafters of a roof, over a foot wide and five feet long.

The size of the spider not only makes it good material for the morphologist, but also increases its interest as a pet. There is a vigour and strength about its actions in a fine large cage which is lacking in the smaller species. It shows an enviable superiority when dealing

with bluebottles, and even wasps, and is indeed well capable of tackling most of the creatures likely to come its way. There is, however, a story in Staveley's *British Spiders* about a spider of this species which may bear repetition. I am bound to say that I have never yet observed anything like it.

The spider had bitten an ant, but before the latter was dead, left it, and ran to an earthen flower-pot the edge of which it seized in its fangs. Here it remained for a time, and left on the porous surface a wet blotch half an inch across. Then it finished off the ant. The conclusion was that the spider had been irritated by the formic acid in the ant and adopted this method of obtaining relief. Readers who are impressed should not fail to offer their pet spiders some nauseous diet such as this, with the alternatives of brick-dust, filter-paper, and anything else that occurs to them!

Fig. 8. *Tegenaria guyonii.*

But interesting as *T. atrica* is, it can scarcely be compared with a species that surpasses it in size, *T. guyonii* (also called *T. parietina* and *T. domestica*) (Fig. 8). This spider is not so plentiful as *T. atrica*, because it is much more local in its distribution. It is, indeed, almost confined to the midland and southern parts of England and Wales, and even there it is by no means ubiquitous. It sometimes lives out of doors.

In addition to its size, 20 mm. long, with legs in the male passing 60 mm., this spider is very easily recognized by its distinct pattern. There is a red-brown band along the middle of the abdomen, running between two pale yellow spots with irregular black borders. The sides are also spotted and streaked with black. The *tout ensemble* produces a decidedly handsome spider, and it is not surprising that it has long attracted attention. Hence it is one of the very few spiders in Britain that have received nicknames—a name, that is, which is not merely a translation of the Latin of the specific name.

This name is 'The Cardinal'. The spider is particularly common at Hampton Court, and it is there that this name originated. Tradition says that the spider terrified Cardinal Wolsey, in honour, if honour it be, or in derision of whom the name was bestowed upon the spider.

There is one other common *Tegenaria*, by name *T. campestris*, which resembles *T. atrica* in pattern, but is only 7 mm. long. This spider is most usually found out of doors, where, like *T. atrica*, it spins its web low down by the roots of trees or under the shelter of stones.

This fourth species has only been mentioned because the four *Tegenaria* together illustrate an extremely interesting phenomenon and provide a better example thereof than is to be found among other spiders. The facts that have been mentioned may be tabulated thus:

1. *T. derhamii.*[1] Nearly always indoors.
2. *T. guyonii.*[2] Usually indoors, sometimes outside.
3. *T. atrica.* Sometimes indoors, very often outside.
4. *T. campestris.* Nearly always outside.

[1] *T. civilis.*

[2] *T. domestica* of Blackwall.

There are here, therefore, what may best be described as four consecutive terms of a series; a set of definite facts of natural history which must have some cause, reason, or 'explanation'. Yet what explanation can be given; to what cause can be assigned the responsibility for the distribution which is its result? It is extremely hard, if not indeed impossible, to answer this question. The spiders have each a different environment. They ought, therefore, if there be any relation between environment and structure, to show structural distinctions in correlation with their environmental distinctions. Yet in the system of classification, which is based on structural features, they are all, quite properly, put within the limits of a single genus.

Yet we cannot abandon the belief that structure is suited to environment. If it were not so, every spider, and indeed every animal, could live anywhere. The only possibility is that the spiders have some differences in habits, some different responses to environmental changes which, although they are apparently not connected with any morphological details, are none the less sufficient to determine a different habitat for each species. A careful and comparative study of the habits of these four spiders might produce results of intense interest. At any rate, I present the suggestion to the readers of this book.

It will readily be seen that spiders, with their capacity for living in unusual situations and undergoing prolonged fasts, are well able to achieve distribution as stowaways. This they have frequently done, and have, moreover, successfully established themselves in the land of their adoption. Several *Tegenaria* provide examples, and,

in Ireland particularly, species imported from America and elsewhere are to be found living contentedly.

Any one who looks for spiders will speedily find, out of doors, common members of two other genera of this family of Agelenidae.

Quite the commonest and most conspicuous of all outdoor Agelenidae is *Agelena labyrinthica* (Fig. 9). This spider inhabits a large shining white web of typical cobweb form during the months of July, August, and September. It has a remarkable preference for gorse, and it is scarcely ever to be found on any other bush if gorse is available in the neighbourhood. The spider itself is a good-looking creature, 13 mm. long, with a rich brown cephalothorax and a dark abdomen marked with paired grey bars on its upper side. These almost meet in the middle, forming an angular mark like a broad arrow.

FIG. 9. *Agelena labyrinthica.*

Like the house spiders, this spider stands expectant in the tube of the web, waiting for the welcome vibration of the sheet. It is a wary customer, and by no means easy to catch; a collector usually misses several before he succeeds in catching his first. The nature of gorse does not make matters easier, and the spider seems almost to realize this fact.

Its tube leads away into the middle of the bush, and down it the startled spider retreats, dropping as a last resource out of the web altogether into the thickest and prickliest of sanctuaries.

Late in the summer the spider constructs its cocoon in

a special chamber which is one of the most wonderful creations in spiderdom. It is a hollow globe-like structure of the whitest silk, within which, near the top, is suspended the cocoon, containing the precious eggs padded round with silken cushions.

Although in nature this spider never lives indoors at all (and might perhaps be added as a fifth term to our series), it is perfectly happy in captivity. In a cage such as is used for house spiders it will spin both its web and its cocoon-chamber, offering good opportunities for observing these activities. Mr. Warburton was the first to do this and to describe his observations in detail. In order to watch the operation of egg-laying and cocoon-spinning, he sacrificed nights of sleep, an example which my readers should be prepared to follow.

There is one feature of the life of *Agelena labyrinthica* which is as pleasing as it is uncommon. At mating-time the male and female spiders live in harmony on the same web without a sign of those disastrous lovers' quarrels of which the whole spider race is often, and quite unjustifiably, accused. This forbearance they exhibit when in captivity, and my experience of the way in which a pair once shared a fly has already been described.

There are also Agelenidae that live in damp, shady places, almost on the ground, under the shelter of stones. These belong to the genus *Coelotes*, the commonest species being *C. atropos*. This spider is 12 mm. long; its cephalothorax is brown, darkest in front, where it is broader than in *Agelena*. The abdomen has a central black band with brown lateral angular bars.

Its web is more cramped than the web of *Agelena*, and is not so clean. Its cocoon is fastened to the stones and

covered with silk blankets. The spider evidently prefers darker and damper situations than the majority of the family, but there is no reason for supposing that it would not take to captivity as kindly as any. As far as I am aware, this has not yet been attempted, and the habits of the genus are unstudied. It is another of the many

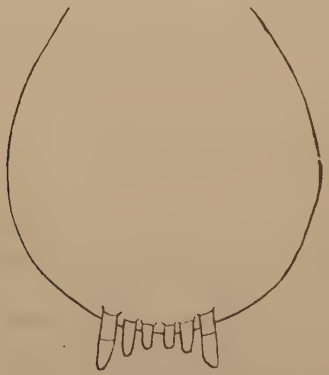


Fig. 10. Spinnerettes of *Hahnia*.

small pieces of active arachnological investigation which I have occasion to point out in this book, and which might so easily be carried out by my readers. It is quite certain that this particular one would yield interesting results.

Further, there is a group of small spiders which have been regarded both as a sub-family of the Agelenidae and as a separate family. These are the genus *Hahnia*, and their interesting characteristic is their peculiar arrangement of the spinnerettes (Fig. 10). Instead of being grouped together, these are spread out across the posterior of the abdomen in a transverse line, with the

longest on the outside. The value of this unique arrangement is at present unknown, but one or two species of the genus are by no means uncommon, and a careful study of their habits would probably reveal unsuspected methods.

Including the water spider, *Argyroneta aquatica*, there are, in all, eight genera of British Agelenidae, with about sixteen species, and two genera of Hahniidae, with six species.

The genera may be separated by the use of the following table.

AGELENIDAE

A. Inferior spinnerettes contiguous; colulus present.	ARGYRONETA.	1. *A. aquatica.*
AA. Inferior spinners separated.		
B. Lip longer than wide; posterior coxae contiguous.		
C. Posterior row of eyes very recurved.	TEXTRIX.	1. *T. denticulata.*[1]
CC. Posterior eyes straight or procurved.		
D. Both rows very procurved.	AGELENA.	2. *A. labyrinthica* and *A. longipes.*
DD. Both rows straight or slightly procurved.		
E. Chelicerae slightly convex; legs long.	TEGENARIA.	5. See p. 72.
EE. Chelicerae very convex; legs short.	COELOTES.	2. *C. atropos*[2] and *C. terrestris.*

[1] *Textrix lycosina.*

[2] *Coelotes saxatilis.*

BB. Lip not longer than wide; posterior coxae separated.		
C. Anterior tibiae and metatarsi with two spines each.	CICURINA.	1. *C. cicur.*
CC. These joints with more than two spines each.		
D. Anterior eyes straight; posterior eyes small and well separated.	TETRILUS.	2. *T. arietus* and *T. impudicus.*
DD. Anterior eyes procurved; posterior eyes large and approximated.	CRYPHOECA.	2. *C. silvicola*[1] and *C. moerens.*

HAHNIIDAE.

A. Anterior median eyes larger than anterior lateral eyes.	ANTISTEA.	1. *A. elegans.*[2]
AA. Anterior median eyes smaller than anterior lateral eyes.	HAHNIA.	5. *H. helveola, nava,*[3] *montana,*[4] *candida,* and *pusilla.*

[1] *Tegenaria silvicola.*
[2] *Hahnia elegans.*
[3] *Agelena nava.*
[4] *Agelena montana.*

VIII

'SQUINT-EYED, BANDY-LEGGED'

(PHOLCUS PHALANGIOIDES)

If it were possible to select one aspect of the study of spiders more neglected than any other, the choice might well fall on those exotic species whose weird body-form almost renders them freaks, as if the whims and caprices of an evolutionary power endowed it with a sense of humour. Of these angular and aberrant forms, the British Isles have none, or none of the worst, but one of our commonest spiders is a species that is different almost in every way from the majority of its kind. The name of this fascinating creature is *Pholcus phalangioides*.

Whatever criticism may be levelled at scientific nomenclature as a whole, it is hard to deny that the name of this spider is almost perfect, and the most suitable that it could possibly have received. The word φολκός occurs in Homer's description of Thersites, and Liddell and Scott will tell you thereof, 'squint-eyed or, more probably, bandy-legged'. It is a stroke of genius, if ever there was one, to select that word as a name for such a spider.

Any one who has once seen it will recognize it at once

from a description, however imperfect. The spider is about 8 mm. long, one quarter of which total length is occupied by the cephalothorax, while the other 6 mm. are taken up by the disproportionately long cylindrical abdomen. The general colour is pale yellowish-brown, with irregular dark markings on the middle of the abdomen, and some fainter spots on the sides. The legs, which are no less disproportionate, and earn it

FIG. 11. *Pholcus phalangioides* and eyes.

the trivial name of *phalangioides* or 'like a harvestman', are some 50 mm. long. They are very slender and pale yellow in colour, with dark swollen joints, and afford a further means of recognizing this remarkable species. It is a bandy-legged villain indeed, and if one looks through a lens at the curious arrangement of its eyes, one can very well imagine that it probably squints as well! (Fig. 11).

This spider is very common in the southern counties of England. The Rev. O. Pickard-Cambridge speaks of it as being probably an importation, which has found such favourable circumstances in its new home that 'it is now an unmitigated pest on my premises and in the

parish church, among the organ pipes'. Its activities are more or less confined to the warmer parts of this country. I have found it plentifully in Cornwall, Dorset, Hampshire, and Sussex, but never in London, Oxford, or Cambridge. On the other hand, I have come across it in Wales as far north as Harlech, a part which is well known for the mildness of its climate, and have also found a single specimen in Malvern. J. H. Emerton records that it is common in the southern States of America, and 'probably imported', so that one is inclined to wonder where its original home really was, and why it has migrated so widely.

Pholcus usually spins her web near the ceiling in rooms, sheds, and barns. At the beginning it is almost sheet-like, a horizontal net with a very wide mesh, but when it is finished and in use it spreads upwards and downwards as a tangled maze of wandering threads. From somewhere in the middle or near the top of this hangs the spider, upside down, waiting for the arrival of the blundering fly.

Through the threads of this loose and scattered web, many insects might be able successfully to force their way, were it not that steps are taken to detain them. Whenever an insect shows signs of becoming entangled in the web, and often even when a person approaches it, the spider gives itself a rapid vibratory movement which shakes the entire web and serves further to entrap the struggling prey. This habit, which is shared by several members of the common genus *Epeira*, is not very easy to observe precisely, with full attention to detail. It is chiefly of interest because *Pholcus* often follows it up with another action common among Epeiridae, that of

twisting the captive round and swathing it with silk, so that it can be kept as a reserve of fresh food for a later occasion.

Like all other spiders, this species is not particular about its food, and I have known two which, for a period of some weeks, lived almost solely on woodlice, and seemed to thrive on a crustacean diet.

W. H. Hudson, in *A Naturalist on the La Plata*, tells an excellent story of the habits of *Pholcus* when it has caught a fly. He says that the spider makes a long and laborious task of killing its captive, whose shrill cries excite other spiders in the neighbourhood. Presently these leave their own webs to visit the scene of the disturbance, when perhaps the boldest spirit will rob the victor of his meal. But after a time, the spider that catches a fly hurriedly covers it with silk and drops it, letting it hang at the end of two or three feet of thread. 'The other spiders arrive on the scene and, after a short investigation, retreat to their own webs; and when the coast is clear, our spider proceeds to draw up the captured fly.' Like another story in this book, this one, too, 'se passe en Amérique'.

Pholcus is one of those estimable spiders which live a peaceable conjugal life. In July the male and female are often to be found sharing the same web; nor does such intimacy ever develop into tragedy. In August the lady of the household lays her eggs, manufactures what passes for her cocoon, and vaunts it abroad. In this respect she is unique. Most spiders prepare for their eggs a closely-woven sheet, whereon they are deposited. They are covered then with a second layer of silk, and the cocoon, usually after some further protection, is hung

or fixed in an inconspicuous place. The eggs of *Pholcus*, however, stick slightly to one another in the form of a small sphere, and the mother surrounds them with so spare a covering of silk that they are always quite visible and unprotected. But she never lets them out of her grasp ; she does not attach them to her spinnerettes, as

Fig. 12. First leg of *Ero*.

wolf spiders do, but grasps them in her falces. How she manages to feed, if indeed she does not willingly starve, while they are in her care is a question as yet undetermined.

This maternal care she extends to the young after her eggs have hatched, and her appearance, curious as a maiden and weird as a wife, is even more remarkable as

a mother, with her brood of fifteen or twenty young ones clinging to her jaws.

This spider is the only member found in Britain of a large and interesting family; it assuredly possesses characteristics which mark it off, very decidedly, as something quite out of the ordinary, among the spiders of this country. For there are some weird spiders in the world, and here and there we get hints of them in our British fauna.

We may thus mention here, to conclude this chapter, a very curious genus, some members of which are not uncommon. This is *Ero*, of the family Mimetidae. The family characteristic is the arrangement of spines on the first two legs, which bear a series of large spines with shorter curved spines between (Fig. 12). *Ero* is the only British genus with three species. They have a hunchbacked sort of abdomen, towering up above the cephalothorax, and adorned with projecting tubercles on the top.

IX

SPIDERS WITH SIX EYES

(THE FAMILIES DYSDERIDAE AND OONOPIDAE)

In the study of any object, living or lifeless, there is always a peculiar attraction about the abnormal or aberrant forms. What, if any, is the cause of their abnormality, what is its significance, how does it affect them?—these questions at once suggest themselves.

Among the spiders of Great Britain there are nearly a dozen species which differ from all the others in that they possess only six eyes instead of eight. There is also a single species with only two eyes.

In former years, when the study of spiders was in its infancy, John Blackwall divided the British spiders into two tribes, the Octonoculina and Senoculina. It seemed, at the time, an easy, useful, and obvious classification, but, despite these advantages, it was not a natural subdivision. For, although the species which it brought into association all had the character mentioned, they were not more closely related to each other than to certain eight-eyed families of the other tribe. The history of the Senoculina is, in fact, a good example of the mistakes which result when classifications are founded on incomplete knowledge.

However this may be, the old tribe still makes a convenient group, which includes representatives of three families, the Dysderidae, Oonopidae, and Scytodidae.

A very excellent place in which to look for spiders of many sorts, particularly during the spring and early summer, is the narrow space under the bark of a dead or fallen tree-trunk. In this asylum numbers of spiders pass the winter, and among them the three commonest six-eyed species are often to be found. These three are called *Segestria senoculata*, *Harpactes hombergii*, and *Oonops pulcher*. Indeed, on one occasion I found specimens of all three of these spiders simultaneously under the same piece of bark, only a few square inches in area.

Fig. 13. *Segestria senoculata.*

The *Segestria* is the one that will first attract attention. It is a spider which reaches a length of 12 mm. when fully grown, with a glossy brown convex cephalothorax and a dull yellow abdomen strikingly decorated with a row of the dark brown lozenge-shaped marks that are generally associated with the 'warning coloration' of the adder (Fig. 13). It looks as though it should be a conspicuous specimen, but as a matter of fact it is very well protected. The femora of its legs are a brighter tawny colour, and as the spider runs they flash to and fro and catch the eye. Then suddenly the spider stops, folds its legs, femora downwards, over its cephalothorax, and is lost to view. The remarkable feature about this method of protection is that examination of the dead spider in the laboratory scarcely suggests its existence—and this is true of other 'flash-coloured' spiders. It is only the collector of spiders who has come up against it who can realize

what species have adopted it. But about its efficiency there is no doubt.

The other *Segestria*, *S. Florentina*, is a spider that is very rare in England, but any reader who crosses the Channel will find it in abundance in the north of France. It is a fine large creature, 18 mm. long, brown all over, and with beautiful brown legs and iridescent chelicerae which are covered with tiny green scales. It inhabits crevices in brickwork, which it lines with a tubular web. This tube may vary in length from 3 to 8 cm., and is about 7 mm. in diameter. At its mouth it widens to form a bell-shaped orifice. The silk here is several layers thick and interwoven with the remains of beetles, flies, and insects of all sorts. From the edge of the widening mouth radiate twenty to thirty plain threads of silk, about 4 cm. long, and not connected in any way. These may, perhaps, assist in catching the wandering insect, although I have failed completely on innumerable occasions to provoke any response on the part of the spider by touching these threads, while a tap on the tube edge brought her out, all ferocity.

As this spider lies in wait in the tube of her web, three pairs of her legs can be seen. The fourth pair are smaller and paler coloured than the rest, and are of course always directed backwards, but the noteworthy peculiarity of this spider is that she has adopted the habit of turning the third pair forwards, so as to be able to use, in the mouth of the tube, all six limbs against the circumstances of life.

Oonops pulcher is a small spider, only 2 mm. long. It is a bright reddish-brown all over, with long hairs on its abdomen and legs. Its six eyes are large and oval in

shape, and make the genus quite unmistakable. The spider is found out of doors on the leaves of bushes in many parts of England; its congener, *O. domesticus*, lives in sheds and houses, and is much rarer. The two

FIG. 14. Some six-eyed arrangements.

species are closely allied, and the existence of the latter has only been recently recognized.

Harpactes hombergii is also found frequently in houses. It is a spider built on delicate lines, 6 mm. long and quite slender, the cephalothorax glossy black and the abdomen a uniform brown. The male is much more handsome than his mate, owing to ruffs of long black hairs which embellish his legs.

Both *Diblemma* and *Ischnothyreus* are really recent importations from warmer climates, and are at present only to be found in greenhouses. It is not, however,

altogether logical to exclude them from the list of British spiders, for it is quite possible that they will succeed in establishing themselves here, as other spiders and as other animals have done, and, indeed, as man himself has done before them.

Diblemma has only two eyes, and both spiders show a curious primitive feature in the existence of a series of segmental plates of chitin on the dorsal side of the abdomen. They are, in fact, survivals of an earlier evolutionary stage, through which arachnida as a whole have passed, a stage in which all visible external signs of segmentation had not yet been lost.

Little or nothing is known of the habits of most of the six-eyed spiders: like the Thomisidae they present a virgin field to the original investigator, a field from which results of the greatest interest are to be expected.

The six British Dysderidae are quite easily separated, on the lines of the following table:

DYSDERIDAE.

A. Tarsal claws two; eyes in a horse-shoe-like figure.	DYSDERA.	2. *D. cambridgii*[1] and *crocota*.[2]
AA. Tarsal claws three.		
B. Eyes form an almost complete circle.	HARPACTES.	1. *H. hombergii*.[3]
BB. Eyes in three groups of two.	SEGESTRIA.	3. *S. senoculata, bavarica,* and *florentina*.[4]

[1] *Dys. erythrina.* [2] *D. rubicunda.* [3] *D. hombergii.*
[4] *S. florentina.*

The five Oonopidae arrange themselves thus:

OONOPIDAE.

A. Abdomen soft.	OONOPS.	2. *O. pulcher* and *domesticus.*
AA. Abdomen with chitinous scuta.		
B. Eyes two.	DIBLEMMA.	1. *D. donnisthorpii.*
BB. Eyes six.		
C. Eyes form a completed ring.	ISCHNOTHYREUS.	1. *I. velox.*
CC. Eyes in a horse-shoe opening in front.	TRIAERIS.	1. *T. stenaspis.*

X

THE WATER SPIDER

(ARGYRONETA AQUATICA)

A SPIDER which, alone of all the thousands of species in the northern hemisphere, has assumed the habit of living under water, must certainly be a creature well worthy of attention. This fact has been so obvious for so many years that *Argyroneta* is a popular inhabitant of aquaria, and its habits are fairly well known and have often been described. It is probably the only spider in the world that invariably provokes the admiration of all beholders from the first moment that it is seen. These facts place the spider in a proud position, and indeed, it is well worthy of commendation.

It is a little disappointing to realize that most of the popular admiration is bestowed, not on the spider itself, but on the bubble of air which surrounds it. The spider, of course, does not breathe like a fish; when swimming under water it is covered with a layer of air because its abdomen is coated with thick-set hairs which are not wetted by the water. When seen from above, this air-bubble shines with an unrivalled silvery brightness, so

beautiful a spectacle that one's first sight of this dowdy little spider entering the water and transforming itself into an elfin fresh from fairyland is one of the experiences in life that can never be forgotten.

When the air in this bubble becomes exhausted, the spider swims to the surface and raises her abdomen above it. As she dives again, the surface sinks with her, preserved unbroken by capillary attraction, until her spinnerettes have disappeared. Then the original level is restored, and a bubble of air is cut off beneath, clothing the spider once more in her silvery mantle.

Argyroneta spins for herself under the water a silken home on the same principle as the diving-bell. The actual manufacture of these domes, spun as they are of the finest silk threads immersed in water, is exceedingly difficult to observe. At the beginning, the results of the spider's work are quite invisible, and can only be inferred by watching the movements of the creature herself, or, better still, the effects of the tension of the threads on the neighbouring leaves and stems to which they are attached.

It would seem that the first stage consists in the fixing of a number of horizontal threads that cross each other at about the same place. This invisible platform grows in density until the spider brings from above the water the first bubble of air, which she releases beneath it. Thus the platform is buoyed up into the form of a dome, and incidentally the visibility of things is somewhat increased.

The provision of the air-supply is now continued for some time, by many repetitions of this process. Finally, when the dome is full enough, the addition of further

threads to increase its strength is undertaken, until the texture closely resembles that of the webs spun by other spiders of the family Agelenidae.

This description evidently implies the fact that the spider can obtain air from above in two different quantities, the smaller of which meets her personal requirements, while the larger is employed for filling the bell. How is this achieved? When the spider raises her abdomen out of the water, she stretches out her fourth pair of legs at some distance from her sides. These legs are provided with a thick brush of exceptionally long hairs, and the result is that when the spider dives again an extra layer of air clings between the sides of the abdomen and the inner sides of the legs. As she swims down, the fourth pair of legs maintain their rigid positions, and thus she enters the bell. Here the excess air is liberated by bringing the fourth legs together, and when the spider swims out again she is seen to be using them in the ordinary way.

The water spider lives for several years, and each year she builds at least two diving-bells. The spring dome is usually made in the manner described above, attached, not far below the water's surface, to plants whose growth provides it with effective concealment. Later in the year the spider goes into winter quarters. Her autumn retreat is deeper in the water and is made of very closely woven silk. It is often spun within the shelter of some solid object, such as a piece of broken bottle or an empty snail-shell, and its shape, instead of being a natural hemisphere, is determined by that of its protector. Instead of being open below, it is closed, and the spider hibernates passively within.

Two cocoons are spun during the year and are placed, in normal circumstances, one in each diving-bell.

The male *Argyroneta* is the only common spider which is larger than the female. At the mating season he builds close to the dome of the female another of similar shape but smaller size. He then joins the two by a silk passage between them, and by tearing away the walls unites the two air-bubbles. He has therefore much hard work to do before he can press his suit, and when the labour is accomplished he has little space in which to indulge the acts and antics of courtship that many lady spiders appreciate. Poor thing! Perhaps it is as well that he is the larger and stronger partner.

This short account of the habits of the water spider make it quite clear that it is in very many ways different from its relatives. The difference to any live creature, animal or plant, between living in air and living in water, must be enormous; in fact it is so great that, generally speaking, special adaptations are necessary for either medium. It is therefore generally a simple matter to determine, by examination of a dead creature, whether it was in life aquatic or terrestrial.

But *Argyroneta* shows no striking morphological adaptations. It is a very ordinary looking spider, of a dark brown colour, and quite devoid of any trace of pattern on its back or of rings on its legs. It is of a globular, rotund form, and its length is 12 mm. When it is examined with a lens, a few small peculiarities can be made out. Its anterior median eyes, for instance, are on a raised tubercle, a form of setting usually confined to lateral eyes, and its legs are excessively hairy. This is particularly true of the fourth pair of legs, the hairs of which are

long and curved like an eyelash, instead of being straight as are the hairs of other spiders. But these are curiously insignificant structural differences to correspond to so complete a difference in habits and habitat. Indeed, if an *Argyroneta* were examined by a mere morphologist, who never undertook field work, he would probably have no inkling of the spider's unique character. He would be more than likely strenuously to deny its possibility.

XI

CRIBELLATE SPIDERS

(THE FAMILIES DICTYNIDAE, AMAUROBIIDAE, ULOBORIDAE AND ERESIDAE)

MENTION has already been made of the existence in some spiders of a spinning organ called the cribellum (Fig. 15). This cribellum is a perforated plate situated

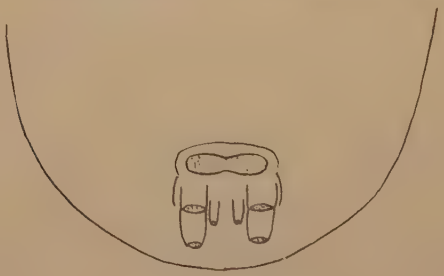


FIG. 15. The Cribellum.

just in front of the spinnerettes and provided with special silk-producing glands, and it is probably correct to regard it as originating from the two additional spinnerettes possessed by *Liphistius*, the primitive spider of Malaya.

A number of spider families possess this organ, but they are not, for that reason, more closely related to each other than to any of the ecribellate species. In the course of evolution, cribellated forms have given rise both

to fresh cribellated and to uncribellated forms, so that it is not possible to regard the presence or absence of the cribellum as dividing all spiders into two sub-orders.

The British cribellated spiders include some of the largest of our native species, and they are spiders which are easily found because of their obvious and characteristic webs. These webs are recognizable by the bluish colour of the silk composing them. The colour, like that of a

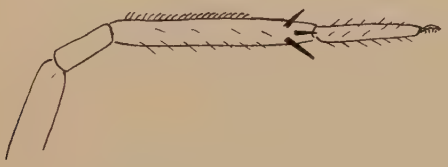


Fig. 16. The Calamistrum.

soap bubble, is due to the interference of light, produced by the band of many fine silk threads combed out of the cribellum by the calamistrum or row of bristles on the metatarsi of the fourth pair of legs (Fig. 16).

The web is a quite irregular jumble of these bluish bands disposed round the hole in which the spider lives. If the web is carefully touched with a spike of grass or, better, the vibrating prong of a tuning-fork, the spider will immediately come rushing out, and, discovering the deception, will as quickly dart back again to its home. If a fly is dropped into the web, the spider will, naturally, come out in the same way, and carry it off, and after a little education will come and take a fly from one's fingers.

Amaurobius similis is a large species, the female of which is 1·3 cm. long, frequently found in sheds and out-

houses. It is brown in colour, with white markings on the abdomen, and is most generally, though not exclusively, a house-dweller. *Amaurobius fenestralis* is a similar spider but much smaller, and generally lives out of doors. It is very common under the bark of trees, where it hibernates in a thin silk chamber. The third British member of the genus is *Amaurobius ferox*, a spider which is as large as *Amaurobius similis*, but black where the latter is brown. It well deserves its name, for it has no hesitation in plunging its falces into the fingers of its captor. It is exceedingly common all over England, both out of doors and in houses. 'Sport, of a kind,' says Pickard-Cambridge, 'has been furnished by ferreting out this spider from its tubular retreat, making use of the uncanny-looking black beetle popularly known as the Devil's Coach-horse, as a ferret.'

There is a fourth, much rarer, member of the family Amaurobiidae, known as *Titanocca quadriguttatus*. By some authorities the two genera are regarded as one. If they be divided, the table of British Amaurobiidae is as follows:

AMAUROBIIDAE.

A. Spines on first tarsi only; lip semi-elliptical.	TITANOECA.	1. *T. quadriguttatus.*
AA. All tarsi with spines; lip truncated in front.	AMAUROBIUS.	3. *A. ferox*,[1] *similis*[2] and *fenestralis*.[3]

These spiders are lovers of darkness, and in the daytime are hiding away in the cracks and crevices which

[1] *Cinflo ferox* and *C. mordex*. [2] *C. similis*. [3] *C. atrox*.

contain their webs. But the Dictynidae are more arboreal. From the hedgerows there may often be beaten a small cribellate spider, 2·6 mm. long, with a darker brown oval patch on the fore part of its abdomen. This belongs to the genus *Dictyna*, of which two species, *Dictyna uncinata* and *Dictyna arundinacea*, are very common. They are very similar, but may be distinguished from one another by the smaller size of the former. *Arundinacea* exceeds 3 mm. in length. The other members of the family, which include representatives of two more genera, are less frequently found. The table of genera is :

DICTYNIDAE.

A. Clypeus much broader than anterior eyes ; posterior eyes slightly recurved ; maxillae rather long and converging.	DICTYNA.	7. *D. arundinacea*,[1] *uncinata*, *arenicola*, *pusilla*, *latens*,[2] *variabilis*,[3] and *viridissima*.
AA. Clypeus slightly broader than anterior eyes ; maxillae short and parallel.		
B. Posterior eyes small, wide apart and recurved.	PROTADIA.	2. *P. subnigra* and *patula*.
BB. Posterior eyes large, close together, and slightly procurved.	LATHYS.	1. *L. humilis*.[4]

The family Eresidae is represented in Britain by a famous but very rare species, *Eresus cinnabarinus*. Only a few

[1] *Ergatis benigna*. [2] *E. latens*. [3] *E. pallens*.
[4] *Ciniflo humilis*.

specimens of this spider have been caught. It is 8 mm. long, with a black cephalothorax which is broad in front. The abdomen is bright scarlet, with four large black spots, edged with white, forming a square on its upper surface. Its vivid coloration and extreme rarity combine to make this species of great interest.

The Uloboridae includes but two species, both rare.

Uloborus Walckenaerii[1] spins a web which resembles that of the Epeiridae to some extent, with the addition of a ribbon of silk crossing it perpendicularly. The ribbon does not pass the centre, where the spider hangs upside down and fills the gap. The male has no calamistrum when mature and probably never spins a web after its last moult. The interesting feature of this spider is that the character of its web shows that the cribellate spiders cannot be taken, as a whole, to form a homogeneous group.

Hyptiotes paradoxus is the famous triangle spider, which has several times been described in American literature because of its unique web. The web is triangular and resembles three segments of an *Epeira* web. The spider in its retreat holds a thread attached to the apex of the triangle, and when the arrival of an insect is signalled, lets the thread spring out, so as to jerk the web and further entangle the captive. The spider has been found on a few occasions in various localities in Britain, and is commoner in America. A fuller description of these two species, by Dr. A. R. Jackson, is to be found in the *Lancashire Naturalist* for May 1910 and April 1911.

[1] *Veleda lineata* of Blackwall's book.

XII

SPIDER-DWARFS

(THE FAMILIES THERIDIIDAE AND LINYPHIIDAE)

THE majority of the spiders described in the preceding chapters are of reasonable size, and some of them may even be described as large. There are, however, two important families whose members, with a few notable exceptions, are much smaller creatures. Both these families are web-spinners and their species are numerous and widely distributed. They make up in numbers what they lack in size, so that nearly all over England collectors find that they make up the greater portion of a day's catch.

The Theridiidae are essentially spiders of the summer; only their exceptional members survive the winter. Their webs are primitive constructions, and consist of nothing more than a tangled maze of crossing threads, in the arrangement of which no scheme or order is apparent. Somewhere in the middle of this entanglement the spider makes a place of rest and concealment for itself by curling up a leaf or drawing a few small leaves together with a band or two of silk. These webs are exceedingly common on bushes and hedges between April and September.

As a rule they are high above the ground, out of the protection of the undergrowth, and exposed to winds and

sun. Their openwork construction and the absence from them of any wind-resisting sheet is obviously to be correlated with this situation, as is the fact that the spiders themselves have coloured abdomens with a pattern of some sort on their upper surface.

There is not very much to record about the habits of the family as a whole; indeed there is not very much known. They seem to lead inoffensive and unexciting lives, without any marked individualities: lives in which the climax is the making of the cocoon.

They are, unlike their near relatives the Epeiridae, quite easy to keep in captivity, though they do not spin the normal type of web when imprisoned in a plain box. In such circumstances at least, they are ready polygamists and polyandrists. Some females which lived under my observation some years ago were mated daily to different male spiders, whose attentions they received without demur. Nor was there, on the part of the males, any show of courtship before mating, nor of stay-at-home intentions after. They wandered unconcernedly away, and, after serving three or four more females, soon died.

The cocoons which the female *Theridion* spins are among the most original found in spiderdom. Often they are coloured, cream, yellow, green, or brown; usually they hang up in the leafy canopy in the web, but sometimes the mother spider carries them about.

Quite the commonest British member of this family is *Phyllonethis lineata*, a spider 5 mm. long and gifted with conspicuously long legs. The typical form has a clear yellow abdomen with two rows of black spots near the middle line, and in the anterior half a fine black cross, often scarcely defined. A common variety has two

scarlet bands on the sides of the abdomen, obscuring the black spots and making a remarkable and vivid spider. Another variation from the type has a complete scarlet oval on the top side of its abdomen, and yet other varieties are uniformly pink instead of yellow or even pure white. Among all these varieties, the pattern on the underside of the abdomen, a broad dark band from lungs to spinners, remains almost unchanged (Fig. 17). This spider spins its cocoon in July, in which month it is almost the only mature spider that one meets at all frequently. The cocoon is green and spherical, varying a good deal in shade.

FIG. 17. *Phyllonethis lineata*: underside.

A green cocoon is also made by *Theridion sisyphium*, also a very widely distributed and a very beautiful little spider. It is 3 mm. long, with an almost spherical abdomen, marked with white, brown, yellow, and red.

Theridion varians, another common species, produces a beautiful brown cocoon, consisting of the small spherical egg-mass hanging on a delicate thread-like stalk from a little attachment disk.

Another member of the same genus which is quite plentiful is *Theridion bimaculatum*. It is only 2 mm. long, and has a shining globular abdomen, brown in colour, with two small white spots, sometimes coalesced into a pale oval patch, on the upper surface. The female swells to a ludicrous size before laying her eggs in September. She makes a pretty little cream-coloured cocoon, which she carries about with her, clasped in her legs.

Theridion pallens is about the same size, and has a globular abdomen generally yellow in colour, with a small white cross on the fore end of the upper surface. The male is often much darker than the female, with a black, wedge-shaped mark on the cephalothorax and black reticulated pattern on the abdomen, all the black parts being relieved with tiny yellow spots.

Stearodea bipunctata is not always arboreal. It is to be found everywhere, hidden in crevices in woodwork of all sorts, at all times of the year. It is supposed to live for four years, and is the species, already mentioned, which John Blackwall kept alive for so long without food. Its length reaches 6 mm. The abdomen is dark brown, ornamented with a transverse white streak round the shoulders, and sometimes another streak, or row of dots, down the middle. On the upper surface are four small depressions, only half of which were apparently considered when the spider was christened.

Episinus truncatus is a curious form, something like *Pholcus* in its possession of a long abdomen, but the hind end of the abdomen is squarely cut off and has the corners slightly produced into small prominences. It is not uncommon in early summer.

The Theridiidae are a very large family, with about forty-five British representatives distributed among fifteen genera. The following table will serve to separate the latter, but owing to the small size of many of the species, this is never a very simple task.

THERIDIIDAE.

A. Tarsal claws non-pectinate.		
B. Abdomen with chitinous scutum.	PHOLCOMMA.	1. *P. gibbum.*
BB. Abdomen without scutum.	THEONOE.	1. *T. fusca.*[1]
AA. Tarsal claws pectinate.		
B. Abdomen, at least of male, with a stridulating organ.		
C. Sternum bluntly produced backwards between fourth coxae.	CRUSTULINA.	2. *C. sticta*[2] and *guttata.*[3]
CC. Coxae almost contiguous.		
D. Anterior eyes very procurved.	STEARODEA.	1. *S. bipunctata.*[4]
DD. Anterior eyes straight.		
E. Posterior eyes large and close.	TEUTANA.	2. *T. grossa*[5] and *nobilis.*
EE. Posterior eyes smaller and separated.		
F. Lateral eyes separated.		
G. Area of median eyes quadrate.	LITHYPHANTES.	1. *L. corollatus.*
GG. Area of median eyes longer than broad.	ASAGENA.	1. *A. phalerata.*[6]
FF. Lateral eyes contiguous.		
G. Posterior coxae separated.	ENOPLOGNATHA.	2. *E. thoracica* and *mandibularis.*

[1] *Theridion fuscum.* [2] *Th. strictum.* [3] *Th. guttatum.*
[4] *Th. quadripunctatum.* [5] *Th. versutum.* [6] *Th. signatum.*

GG. Posterior coxae contiguous.	ROBERTUS.	4. or 5.
BB. Abdomen without stridulating organ.		
C. Superior tarsal claws regularly toothed.		
D. Posterior median eyes further from laterals than from each other.	DIPOENA.	3. *D. melanogaster*, *braccata*, and *erythropa*.
DD. Posterior eyes equidistant.	LASEOLA.	3. *L. inornata*,[1] *prona*, and *tristis*.
CC. Superior tarsal claws with a few long irregular teeth.		
D. Posterior legs shorter than anterior.		
E. Legs long and slender.	PHYLLONETHIS.	3. *P. lineata*,[2] *lepida*, and *bellicosa*.
EE. Legs moderate or short.	THERIDION.	16 circa. *T. varians*, *bimaculatum*,[3] *sisyphium*,[4] *vittatum*,[5] *pallens*, &c.
DD. Posterior legs longer than anterior.		
E. Third legs much the shortest.	EPISINUS.	2. *E. truncatus*[6] and *lugubris*.
EE. Legs not very unequal.	EURYOPIS.	1. *E. flavomaculata*.[7]

The family Linyphiidae contains about 240 British species, or over two-fifths of the total number of spiders found in this country. It is therefore the family which,

[1] *Th. inornatum.* [2] *Th. lineatum.* [3] *Th. carolinum.*
[4] *Th. nervosum.* [5] *Th. pulchellum.* [6] *Th. angulatum.*
[7] *Th. flavomaculatum.*

alike to the collector and to the serious student, is by far the most important. Nevertheless, it is the least suitable for description in such a book as the present; the species are nearly all so small that their study involves the greatest difficulties and worst problems in practical arachnology. These spiders have usually to be examined under a microscope, and the distinguishing characters are sometimes mere hairs or spines, often in the least easily seen situations. The family, in fact, taken as a whole, converts arachnology from an outdoor sport into a search for microscopical illumination!

The Linyphiidae are essentially northern. The majority of the spiders found in the arctic lands belong to it, and in warmer countries it is far less conspicuous. Even within the limits of the British Isles its predominance increases as we travel northwards.

Our native representatives fall into two more or less distinct groups. The family is allied to the Theridiidae and Epeiridae, but its members have for the most part come to live nearer the ground, in darker and more sheltered places. Some genera still resemble the typical arboreal forms in possessing long legs and a pattern on their backs, and form one sub-family; others have shorter legs and plain dark abdomens, forming the second division.

There are six dozen genera of this family with representatives in Britain. They spin webs which may be described as resembling the irregular webs of the Theridiidae with the addition of a median horizontal sheet of finely-woven silk. This sheet is the home of the spider, which lives inverted on its under side. The tangle of threads above the sheets serves to arrest small flies, which are thrown down on to the sheet where the

spider is awaiting them. These webs are exceedingly numerous in hedges, in undergrowth, and in long grass, but the silk of which they are made is so fine that a morning on which all webs are covered with dew or with hoar frost is needed to enable one to gain an adequate idea of their numbers.

Linyphia triangularis is the commonest and largest member of the family. Its webs may be seen almost everywhere in summer and autumn, but the spider itself is by no means easy to catch. It is absurdly sensitive to one's approach, and has no hesitation in dropping into prickly fastnesses beneath. It is 7 mm. long, with a pattern of transverse black and white bars on its abdomen, and brown legs with greenish femora. Old specimens are often to be caught in which the chelicerae have grown to a relatively enormous length, projecting tusk-like from the creature's head. It is curious that these organs should thus continue to grow in this spider but apparently not in any other British species. A related species, which has a dark cephalothorax and uniformly yellow legs, is *Linyphia clathrata*; another, *L. montana*, has ringed legs.

Many of these small spiders, particularly in the male sex, possess remarkable developments of the cephalic region. The result is that the eyes, or some of them, are raised upon tubercles of various shapes. *Walckenaeria acuminata* possesses the best of these (Fig. 18); it is, however, not a very common spider.

The small dark spiders which we occasionally welcome under the name of 'money-spiders' are of course members of this family. They are more usually found out of doors, running along the tops of railings on gossamer

days, but more generally living among grass roots and low herbage. Two very common species, both black with orange legs, are *Erigone dentipalpis* and *Erigone promiscua*. *Gonatium rubens* is a handsome little spider, orange-red in colour all over.

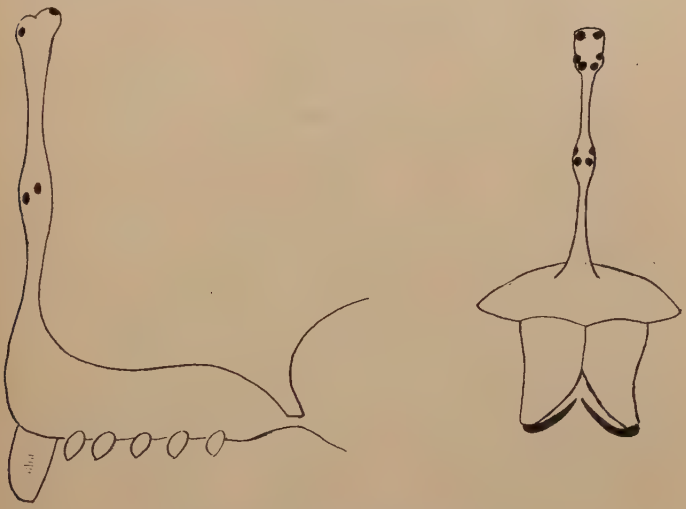


Fig. 18. *Walckenaeria acuminata.*

Many members of the genus *Leptyphantes* are marked with zebra-like black and white stripes, several of these little species being extremely difficult to distinguish from each other. This genus also contains *Leptyphantes nebulosus*, a fairly big cellar-living spider, recognizable by three white spots on the under side just above the spinnerettes.

One might go on for a long time thus briefly referring to the widespread members of this family, but, owing to the

difficulty of being certain of these species without expert examination, no very useful purpose would be served. They may be the dominant spider family in these northern climes, but they are the most difficult to study, and they raise few problems save those of taxonomy.

Their classification has only recently emerged from chaos to comparative order, and for this British arachnologists are indebted to the Rev. J. E. Hull, who, in a modest little paper in the *Vasculum* (1920, vi. 7–11), removes a very large proportion of the obstacles encountered.

The arboreal forms are separated from the smaller ground-loving species, thus producing two sections, the Linyphiales and the Erigonales. These two sections are distinguishable by the following characteristics, to all save one of which there are, however, a few exceptions in each group. The constant character, which is not always easy to see, is the last—the form of the spiracular fold.

LINYPHIALES.	ERIGONALES.
Primary fang teeth 3.	Primary fang teeth 5.
Lip widest at apex.	Lip widest at base.
Legs with lateral spines.	Legs without lateral spines.
Female palp with claw.	Female palp without claw.
Fourth tibia with two erect spines.	Fourth tibia with one erect spine.
Posterior spiracles on margin of mamillary cavity.	Posterior spiracles emote from mamillary cavity

The two sections are split into sub-families, each containing several genera. The characters of these sub-families, as given by Mr. Hull, are quoted here, with the names of the genera they include. To attempt the

separation of the latter would be too lengthy a task for such a book as the present one; but the reader who desires it will find nearly all of them described in the first volume of Simon's *Histoire Naturelle*.

LINYPHIALES.

A. LINYPHINAE.

Femoral spines present on first legs.
One or more lateral spines on tibiae.
Superior margin of chelicerae generally with three teeth.
Tarsi with auxiliary claws

Eleven genera—*Porrhomma*, *Centromerus*, *Labulla*,[1] *Tmeticus*, *Leptyphantes*, *Bathyphantes*, *Troglohyphantes*, *Bolyphantes*, *Linyphia*, *Scaptophorus*, *Stemonyphantes*.[2]

B. MICRONETINAE.

No femoral or lateral spines, as a rule; if present, such spines are small and weak.
Auxiliary claws absent.
Superior margin of chelicerae with two, four, or five teeth.

Six genera—*Meioneta*, *Syedra*, *Rhabdoria*, *Agyneta*, *Micronetа*, and *Aphileta*.

C. MENGIINAE.

Spines as in A and D, or no spines at all.
Superior margin of chelicerae with more than three claws.
Epigynal region scapigerous.
Tarsus of male palp with strong apophysis.

Six genera—*Tapinopa*,[3] *Floronia*,[4] *Drapetisca*,[5] *Poeciloneta*,[6] *Mengia* and *Sintula*.[7]

[1] *Linyphia cauta.*
[2] *Neriene trilineata.*
[3] *Linyphia longidens.*
[4] *Linyphia frenata.*
[5] *Linyphia socialis.*
[6] *Neriene variegata.*
[7] *Neriene cornigera.*

D. HILAIRINAE.

No femoral spines.
One antero-lateral spine on first tibia.
Superior margin of chelicerae with five teeth, inferior with three.

Five genera—*Hilaira*, *Macrargus*, *Oreonetides*, *Phaulothrix*, and *Halorates*.

ERIGONALES.

A. CORYPHAEINAE.

Spiracular fold curved so as to overlap margin of mamillary cavity.
Legs rather long; spines strong.
Chelicerae of male often with small projection.

Five genera—*Diplocentria*, *Coryphaeus*, *Gongylidiellum*, *Œdothorax*, and *Notioscopus*.

B. ERIGONINAE.

Spiracular fold curved but not reaching margin of mamillary cavity.
Legs long but spines weak.

Eight genera—*Maro*, *Ostearius*, *Maso*, *Gongylidium*,[1] *Micryphantes*, *Erigone*, *Lophomma*,[2] and *Dicymbium*.

C. TROXOCHRINAE.

Spiracular fold deeply curved, just reaching margin of mamillary cavity in middle.
Legs rather short; tibial spines solitary.
Tarsi cylindrical.
No long delicate spine on fourth metatarsi.

Six genera—*Savignia*,[3] *Scleroschema*, *Areoncus*, *Diplocephalus*, *Monocephalus*, and *Troxochrus*.

[1] *Neriene munda.* [2] *Walckenaera punctata.*
[3] *Walckenaera frontata.*

D. WIDERIINAE.

Spiracular fold nearly straight, close to mamillary cavity.
Leg spines weak or absent.
Tarsal claws, or some of them, strongly toothed.

Seven genera—*Thyreosthenius*, *Evansia*, *Wideria*, *Walckenaeria*, *Prosopotheca*, *Cornicularia*, and *Tigellinus*.[1]

E. NERIENINAE.

Spiracular fold nearly straight, remote from mamillary cavity.
Body comparatively broad.
Leg spines weak.
Nearly always a long, fine spine on fourth metatarsus.

Fifteen genera—*Hypselistes*, *Caledonia*, *Baryphyma*, *Tiso*, *Acartauchenius*, *Panamomops*, *Peponocranium*,[2] *Pocadicnemis*, *Metopobactrus*, *Styloctetor*, *Entelecara*, *Trichoncus*,[3] *Gonatium*, *Plexisma*, *Neriene*.

F. LOPHOCARENINAE.

As E, but smaller.
Dorsal surface more or less hardened, and often pitted.
Venter with rust-coloured spots.

Three genera—*Ceratinella*, *Lophocarenum*, and *Cnephalocotes*.

[1] *Walckenaera furcillata*. [2] *Walckenaera ludicra*.
[3] *Walckenaera saxicola*.

XIII

GARDEN SPIDERS

(THE FAMILY EPEIRIDAE)

MOST families of spiders have representatives which may be found in gardens, but the family to which the name of garden spider is usually applied is one that is particularly obvious, because of the beautiful circular orb-webs which its members produce.

This family, the Epeiridae, includes the most highly specialized of all the spiders, and shows the extent of its specialization in some unique habits as well as in details of structure. The geometrical web is the most obvious example of this.

Morphologically considered, these spiders are very distinct. They have, as a rule, fat globular abdomens, which are often adorned with conical projections. In exotic genera these protuberances are much more elaborate, and produce the weirdest angular forms, but the British species are not so ornamental.

The spinnerettes are small conical or finger-like processes, arranged in an inconspicuous rosette. It is rather curious that in the most highly evolved family these characteristic organs should be reduced in size, when the contrary might well be expected. The complexity is found in the silk glands within, five different types of gland, as already described, being found in the abdomen.

The legs of the Epeiridae are short and stout, so that the bulky abdomen is not an easy load for them to transport, and the spider is not a great walker. Its legs are intended only for use on the web, and for this purpose they are liberally supplied with tactile hairs and spines. At the tip of the tarsus, several of the spines have developed into saw-edged organs, called accessory claws, and characteristic of the family. (Fig. 19.)

In discussing the habits of Epeiridae there is always

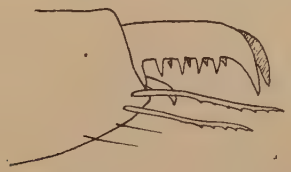


Fig. 19. Accessory claws of Epeiridae.

a risk of telling the reader much that he knew before, because the beauty of the geometrical web is always a magnificent advertisement for the spider itself. The owner of the web sometimes lives under the shade of a neighbouring leaf, its legs touching a thread which keeps it in communication with the centre of the web. Sometimes the spider lives *in mediis rebus*, an exposed situation of whose disadvantages she seems well aware.

A slight disturbance in the neighbourhood usually causes her to indulge in the very familiar oscillations which are presumably intended to make her less easily recognizable. The way in which this curious motion is produced can be watched by forcing the spider to repeat it again and again, until it is so tired that it performs the actions slowly and the details are apparent.

Very often, however, the spider deems the protection given by this device insufficient. In such circumstances she drops bodily out of her web, retaining connexion with it by a rapidly lengthening thread. She does not always drop to the ground; she is on the alert for better concealment, and if she drops upon or close to a leaf she generally checks her fall and creeps beneath it.

In October, the webs of the Epeiridae are often to be found with an amorous male lurking on the outskirts and making tentative advances to the owner. His caution is well justified, for it is in this family that the perils of courtship reach a maximum. The disparity in size between the sexes is more marked than in most other families. One of the genera, *Nephilia*, widely spread in the tropics, includes a species, *Nephilia chrysogaster*, of which the female is two inches long and the male scarcely one-tenth of an inch long.

The cocoons, which often include a coloured cushion of silk round the eggs, are securely fixed by the mother spider in some position, not necessarily concealed, on a fence or tree-trunk. After it is completed the spider takes no further care of or interest in her progeny.

The young spiders most generally hatch in the spring following. They have a quite characteristic habit, in the common species *Epeira diademata*, of forming a closely packed ball of living spiderlings, which must be one of the mechanical wonders of the world, to judge by the economy of space with which those hundreds of legs and scores of pairs of chelicerae are packed away. It is a never-to-be-forgotten sight to touch but one thread of their support, and to see the golden rain of little spiders scattering for a few minutes and then settling

down again. After their next moult they separate and begin to lead independent lives. Their first webs are not quite as elaborate as those of their elders; they are relatively smaller in size and have fewer radial threads.

The process of spinning an orb-web is one of the many sights which must be seen to be appreciated. It is really impossible to do justice to it in words. However, a book on spiders without this description would indeed be a *Hamlet* without the Prince of Denmark, and we must make some attempt at recording its essentials.

The Epeirid web consists of five parts, the framework or foundation lines, the radii, the viscid spiral, the 'notched zone' and the hub. In addition to this, there is usually a thread connecting the hub to the hiding-place of the owner.

The manufacture of the web begins with the laying of the foundation lines. Fixing a silk thread to its starting-point, the spider stretches a horizontal thread by crawling away to some distant spot, holding the thread clear of obstacles by one of its fourth legs stretched out behind it. From the two ends of this line the spider then allows itself to drop, on threads which are attached ultimately to whatever it may be that brings the falling spider to rest. Finally the fourth side of the quadrilateral is completed by taking a thread, fastened to the bottom of one of the perpendiculars, to the bottom of the other, by walking round the three sides.

In this description it has been assumed that a favourable situation for laying the first thread has been found. The spider, however, is often in a position from which

it is impossible to stretch this line by a mere crawl. In these circumstances the spider makes use of the wind. Turning its spinnerettes upwards, it exudes a droplet of silk, which the least breeze carries out into a long fine thread. This, peradventure, will come to an anchorage on some suitable object. At other times, the form of the foundations may be triangular instead of trapezoid. This framework is strengthened by the spider, which now travels all round it two or three times, adding a thread on each journey. These threads are spun from the ampullaceal glands, through the first and second pair of spinnerettes.

The next addition is the radii. After the first two, which stretch from corner to corner, the spider places these alternately on opposite sides of the centre, and shows its truly wonderful instinct in the way in which it can make an almost exact equality of angles all round. When the last radius is secured to the framework, the spider returns to the centre and spins a rough spiral of four or five turns of ordinary thread from the centre outwards to the circumference. The purpose of this spiral, which is a temporary scaffolding only, is to act as foothold to the spider in fixing the viscid spiral.

When the laying down of this spiral commences, the spider changes the character of its movements, which, from being rapid and almost spasmodic, become slow and deliberate. The viscous thread is applied to the radii from the outside, working inwards, forming a nearly perfect logarithmic spiral. As each attachment to a radial thread is made, the viscous thread is rapidly stretched by one of the hindermost legs, and this causes the sticky secretion with which it is covered, by the

aggregate glands, in a uniform cylinder, to break up and collect in a number of equally spaced drops. The spider can work either clockwise or counter-clockwise with equal speed and accuracy; it avoids treading on the new viscid thread, and as this line approaches each turn of the temporary scaffolding, the latter is rolled up by the spider.

Finally the viscid spiral is broken off a short way from the centre. The spider returns to the hub, where she eats the small silk ball made of the rolled-up scaffolding, and sometimes converts the centre of the web into a circle by eating the cushion formed by the crossing radii. The notched zone is added last: it consists of a few turns of spiral in which the circular thread leaves each radius slightly below the point at which it arrives. This process takes in all from half to three-quarters of an hour, and, since the web is often seriously damaged in the course of a night's chase, it is generally repeated each evening during much of the spider's life. The same foundation lines are used as long as circumstances permit.

Among the very numerous species of Epeiridae in foreign lands several modifications of this type of web are found. One, particularly common in England, is spun by the three members of the genus *Zygia*, and may be likened to the complete or normal web with the spiral swept away from two sectors, leaving an isolated radial thread (Fig. 20). This bare radius is the high-road to the owner's retreat, and takes the place of the inclined supernumerary ray which fulfills that function in the completely spiral web.

Another, but far less common, variation is produced by

Cyclosa conica, whose web is crossed by an addition of flocculent pieces of silk forming a band, between two radii. This probably helps in the entanglement of insects, and it is usually found covered with their remains.

Almost the commonest British Epeirid is *Epeira*

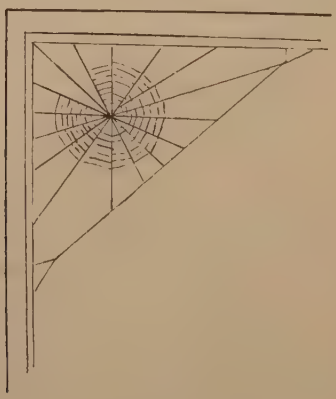


FIG. 20. Web of *Zygia X-notata*.

diademata, the large brown spider to which the general name of 'garden spider' is usually given. To many people not particularly interested in spiders it represents the whole order. The spider does not mature until the autumn, when the female is 15 mm. long and about 8 mm. broad. The male is only 8 mm. long and 4 mm. broad. Its colour varies over a wide range of shades from rich chocolate brown to pale sandy yellow, and the pattern on its back, made up of white marks and spots, is also liable to variation. Usually there is a more or less definite white cross on the anterior part, which has

given this spider the French names of the Porte-Croix and Croix de Saint-Denis (Fig. 21).

Epeira is the largest of the British genera in this family and several other members of it are among the commoner species. *Epeira cucurbitina* is a spider with a brown cephalothorax and a brilliant green abdomen with no markings save four small pits or depressions. It is about 4 mm. long when full grown, not a very big creature but a very beautiful one. Unfortunately its colours always fade after death, whatever liquid be used for preservation.

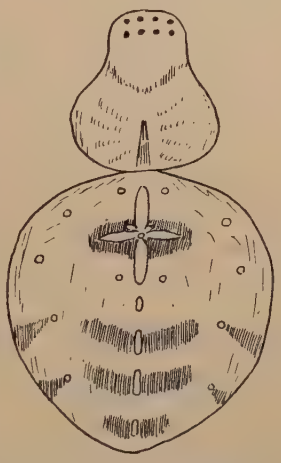


Fig. 21. *Epeira diadematа.*

Epeira umbratica is a less common species but a rather curious one. It is 12 mm. long, black or dark-grey all over, and with a leaf-shaped mark more or less defined on its abdomen by surrounding patches of yellow. It is almost as broad as *Epeira diadematа,* but its abdomen is flattened, and in strong contrast to the bulky angular body of the commoner species. It loves the shade; its web is never built in exposed sunny places, but in the gloomiest situations it can find. The web is characteristic; a large loose structure in which the segments of spiral thread bifurcate before joining the radius. It is thus a useful guide to its hidden owner, but even with the help thus afforded it is not always easy to trace the spider. When caught and dragged into

the light of day, it covers its cephalothorax with its legs, as though shading its eyes. It seems to have an owl-like dislike of sunshine, and would sooner creep into a dark noisome crevice than sun itself on its web as its cousins do.

The largest *Epeira* is *Epeira quadrata*, 20 mm. long, with an almost circular abdomen, reddish in colour and marked with four round white spots.

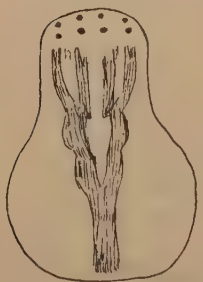


FIG. 22. *Meta segmentata*: Cephalothorax.

Meta is a genus with very long front legs, well represented by *Meta segmentata*, the most numerous of all the British spiders. From spring to autumn it may be found on almost every bush and hedge throughout the country-side. It is as variable in size as in pattern, for it is one of the few spiders that produce two broods in a year, and the spring specimens are much smaller than the autumn ones. The patterns borne by different individuals are not only very difficult to describe, but are subject to so great variations that it is hardly possible to write a description applicable to them all. However, there is luckily a character which is both obvious and constant—the tuning-fork on the cephalothorax (Fig. 22) which enables the varieties to be recognized. Blackwall's name for this species, *Epeira inclinata*, refers to its most remarkable habit, that of spinning its web inclined to the horizon instead of perpendicular. The inclination varies, and in extreme cases the web may be almost horizontal.

The genus *Zygia*, whose web has already been

described, contains three species, two of which are widely distributed over Britain. These are *Zygia atrica* and *Zygia x-notata*, two spiders so closely allied that the separation of the two females, lying on the laboratory bench, is a matter of great difficulty. A helpful feature is the fact that the shoulders of *Zygia atrica* are generally more rufous or tawny than those of *x-notata*, which incline more to black. It is much easier to distinguish them by their habitats, for *Zygia atrica* almost invariably spins its web on bushes, while *Zygia x-notata*

FIG. 23. *Cyclosa conica.*

as invariably inhabits the corners of window-frames and doorways.

Here is, again, the problem which the genus *Tegenaria* suggested. Two spiders, morphologically the closest possible allies, adopt, almost invariably, quite different environments. Why is this so? How can similar structures be adapted to different surroundings? What is the vital difference between the two environments, and on what part of the spider does it react? What is the hidden difference that impels one species to live in bushes and the other in window-frames?

Cyclosa conica, the spinner of the decorated web, is the only British representative of its genus. It is chiefly remarkable for its queer abdomen, whose profile cannot be mistaken (Fig. 23). It is common in America.

Tetragnatha is a genus of five curious species, of which

the commonest, *Tetragnatha extensa*, nearly always spins its web in bushes which grow on the banks of streams (Fig. 24). It is well concealed when it crouches close to a grass stem, its long legs stretched out in front of it, in a position shared by no other genus of spiders. *Tetragnatha solandrii* is also common, and is distinguishable from *Tetragnatha extensa* by its not having on the sternum the distinct yellow spot which that species carries.

FIG. 24. *Tetragnatha extensa.*

The genus *Pachygnatha* belongs to the same sub-family. Two of three species are common. *Pachygnatha degeerii* is 3·5 mm. long, with a black cephalothorax, a black and white pattern on its abdomen, and always easily recognized by its large protuding chelicerae, which project sideways in a characteristic way. *Pachygnatha clarkii* has similar chelicerae; it is longer, reaching 5 mm., and its general colour is yellow and gold.

A scheme for the British Epeiridae is a fairly big task. The table here appended is not in agreement with the sub-families proposed by others who have dealt with the Epeiridae of the whole world, but it should be a practicable one for our British fauna.

EPEIRIDAE.

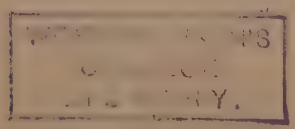
A. Chelicerae without lateral condyle, or with condyle rudimentary.

B. Sternum broadly truncated behind, legs (except fourth tarsi) without spines, eyes heterogeneous. Sub-fam. *Theridiosomatinae.*	THERIDIOSOMA.	1. *T. argenteolum.*
BB. Sternum pointed behind, legs with spines.		
C. Spiracular fold strongly procurved, sexual organs simple. Sub-family *Tetragnathinae.*		
D. Maxillae more or less convergent and not prominent; no accessory claws; lateral eyes contiguous.	PACHYGNATHA.	3. *P. degeerii, clarkii,* and *listeri.*
DD. Maxillae straight and prominent; tarsi with accessory claws; lateral eyes separate.		
E. Eyes in two straight rows.	EUGNATHA.	1. *E. striata.*
EE. Eyes in two oppositely curved rows.	TETRAGNATHA.	5. *T. extensa, obtusa, solandrii, nigrita,* and *pinicola.*
CC. Spiracular fold nearly straight; sexual organs more complex. Sub-fam. *Metinae.*		
D. Anterior median eyes small.	NESTICUS.	1. *N. cellulanus.*[1]

[1] *Linyphia crypticolens.*

DD. Eyes almost equal.	META.	3. *M. menardii*,[1] *merianae*,[2] and *segmentata*.[3]
AA. Chelicerae with distinct lateral condyle; maxillae as wide as or wider than long. Subfam. *Epeirinae*.		
B. Both rows of eyes recurved.	CYCLOSA.	1. *C. conica*.[4]
BB. Posterior row of eyes straight or nearly so.		
C. Posterior eyes equidistant; lip as long as wide.	ZYGIA.	3. *Z. atrica*,[5] *x-notata*,[6] and *stroemii*.
CC. Posterior median eyes closer to each other than to laterals, lip wider than long.		
D. Fourth legs longest.	CERCIDIA.	1. *C. prominens*.[7]
DD. First legs ongest.		
E. Anterior median eyes much nearer to each other than to laterals.	EPEIRA.	19. *E. diadematа, cucurbitina, quadrata, umbratica, cornuta*,[8] &c.
EE. Anterior eyes equidistant.		
F. Anterior median eyes bigger than posterior medians.	SINGA.	5. *S. hamata, herii, sanguinea*, &c.
FF. Median eyes equal.	MANGORA.	1. *M. acalypha*.[9]

[1] *Ep. fusca.* [2] *Ep. antriada* and *celata.* [3] *Ep. inclinata.*
[4] *E. conica.* [5] *E. calophylla.* [6] *E. similis.*
[7] *E. bella.* [8] *E. apoclisa.* [9] *E. acalypha.*



XIV

WOLF SPIDERS

(THE FAMILIES LYCOSIDAE, PISAURIDAE, AND OXYOPIDAE)

THIS family is familiar to most of us, for it contains the dark brown spiders that scamper away from us and our spaniels as we tramp over fields and meadows in spring and summer. In April and May their numbers are immense, they are still numerous in summer, and only disappear as winter approaches. They are to be found in both damp and dry situations, and even on the beach in some parts of the coast.

These are vagabonds, that spin no webs and have no nests, the tramps and huntsmen of spiderland, with no home but the wilds and no roof but the open sky. They are voracious feeders, who, recognizing their prey by sight, pursue and catch it by virtue of their own strength and speed.

Clearly, then, their habits of life are in sharp contrast to those of the house spiders and all other spinners of webs. Hence they show several peculiarities of structure, marking them off as a particularly well-defined family, because, more than most spiders, they make active use of their legs and eyes.

The legs are therefore short and stout, well adapted to

rapid and precise movements. The eyes are large, though not indeed as large as the eyes of jumping spiders. They are placed in three rows on the cephalothorax, embracing thereby a wide field of vision (Fig. 25). They are, quite evidently, really functional organs, able to recognize prey, enemies, or mates at a distance of several inches. Lastly, the spiders of this family are all soberly coloured, being black or brown, with, as a rule, but an inconspicuous pattern.

Fig. 25. Eyes of *Lycosa.*

The habits of wolf spiders are not easy to study continuously. They do not take readily to captivity, seeming to miss, in cages, much that makes life in natural circumstances not only bearable but possible. They need a large cage, for exercise seems to be a necessity, and also a large quantity of food, to supply which takes time. Water, too, is an essential, and probably sunshine has some effect on their vitality. For all these reasons, most of the observations on wolf spiders have been made actually in the open, or on specimens which are living in merely temporary captivity. The result is that a good deal of detail is unknown, but at this we should not grumble, for there is more known about wolf spiders than about many other families.

Although they possess good eyesight wolf spiders are apparently deaf—that is to say, they do not exhibit an obvious response to sounds by raising their legs as do some other spiders. Whether they are, however, altogether unable to perceive sound-waves in the air is another question, and one which it is not so easy to answer. For at mating-time the male Lycosid drums on the leaves

with his palpi, evidently as a call to his spouse. Whether or not his lady wife hears the sound in the air or merely feels the vibration of the leaves is the problem which has to be solved.

The motherhood of Lycosidae is one of their most interesting periods. The egg cocoon, which is made in the summer, is globular in shape, seldom perfectly spherical, but flattened above and below. It is either a brilliant shining white, or dark green or brown, frequently with a paler equatorial band. As soon as it is made, the female spider fastens it to her spinnerettes, and cherishes it with the greatest tenacity of purpose known in spiderdom. She opposes with the utmost of her ability any attempt to rob her of her precious burden, and if it be torn away by brute force, searches for it energetically.

If, during the search, the cocoon come within her range of vision, she does not recognize it! This seems surprising until it is realized that from the moment of its manufacture she has never seen it until now. All she remembers is the feel of it, and should she brush up against it, by so much as a few hairs of one leg, immediately she seizes and replaces it.

She has, therefore, some maternal feeling, but it is a little disappointing to find that her feelings are blindly instinctive and not discriminating. Her very own cocoon is not a whit more satisfying than that of another spider, even of another species. A pith ball or a pellet of cotton wool is just as readily accepted, and one spider has even been recorded to have tried to carry off a lead shot covered with the coating of her cocoon.

It throws some light upon the development of the

spider's mental powers to test the length of her memory for her lost cocoon. Dr. and Mrs. Peckham have shown that the spider generally retains her memory of the cocoon for sixteen or seventeen hours, seldom for twenty-four, and on no occasion for as long as forty-eight hours.

The young spiders escape from the cocoon before they are strong enough to lead an independent life. So they climb upon their mother's back and are carried there for days or weeks. Here again her motherly care is a blind instinct rather than a personal affection for her little parasites, a feeling which is entirely reciprocated. Mr. Warburton describes the following scene: 'Two mother tarantulas, each with her young upon her back, came into contact, and a battle *à outrance* took place. One was slain, but the double brood, scattered by the conflict, climbed, on its cessation, on to the back of the victor, and remained calmly in position while she proceeded to dine in leisurely fashion on the vanquished.'

Fabre has pointed out that although these young spiders often descend or fall from their mother's back, and climb up again, displaying considerable activity, they apparently eat nothing until they are altogether weaned. He supposes that they can absorb solar radiation, and so derive energy directly from the sun. It must, however, be very difficult to make certain that a young spider never eats an insect smaller even than itself. There is also more than a possibility that cannibalism may be encouraged as an economic way of supporting a large family. Whatever be the truth, the young wolf spider recalls our attention to the fact, already mentioned, that the spider throughout its whole life seems to be able to live on the

memory of a meal, and to continue for long periods to produce something for nothing.

Lycosa contains over twenty British species, several of which are extremely common and so closely related that they are very hard to distinguish. The normal pattern in this genus is a narrow median stripe reaching from the pedicle about two-thirds of the way down the abdomen, and usually ending in a point. From here to the spinnerettes there are a number of paired, generally obscure, angular marks. The clearness of the pattern varies greatly in different species, and in the same species before and after death.

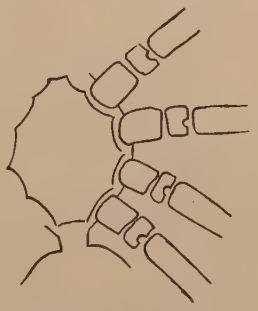


Fig. 26. Notched Trochanters of *Lycosidae*.

Some members of the genus are more than ordinarily interesting, and of these *Lycosa purbeckensis* must be given pride of place. It is a semi-marine spider, found on the sea-shore in some parts of England, where it lives among rank herbage. It is covered with unusually long hairs, and when the tides cover its dwelling-place, it remains submerged, clinging to the stem of a plant. Mr. W. S. Bristowe[1] has shown that submersion for ten hours on two successive days produced no ill-effects. A better example of adaptation to environment than this spider it would be hard to find.

The ability to run on the surface of water is possessed by the genus *Pirata*, whose members are generally found

[1] See W. S. Bristowe, 'A British Semi-marine Spider' *A. M. N. H.* 9. xii. 154-6.

in marshy places. The genus is distinguishable by the double row of white spots on the abdomen. The commonest species, *Pirata piratica*, has one of the clearest patterns of any of the family, indeed its contrasting colours, brown, white, and yellow, make it one of the most beautiful of all British spiders. The female makes a pure white spherical cocoon.

Less inclined to damp places is the genus *Trochosa*. This includes a fine large species, about 10 mm. long, and very common. Its name is *Trochosa terricola*. Its general colour is olive-brown, with greenish-black markings. There is a broad blackish streak on each side of the cephalothorax, and on the abdomen a spear-shaped mark pointing backwards. This mark is the same colour as the other brown parts of the spider, thus distinguishing it from its close ally *Trochosa ruricola*, in which the mark is yellower.

Trochosa picta, too, is noteworthy. It is a prettily marked, indeed an almost gaily coloured wolf spider, 4 mm. long, not easily confused with other species. It lives on sandhills, and its colour varies in different parts of the country to match the prevalent sand. Mr. Warburton has described the burrow which it digs in the sand and lines with a fine layer of silk. The burrow is open above, but is provided with a blindly ending side-tube, into which the spider retreats when frightened.

The classification of the Lycosidae is a problem of a rather unusual type. Several genera were described by the earlier European arachnologists, but an increasing number of 'intermediate forms', subsequently discovered, seemed to make these genera merge into one another, so that Simon united them all under one genus, *Lycosa*.

More recently, however, the North American Lycosidae have been the subject of a wonderfully painstaking monograph by Dr. R. V. Chamberlin, in which the separate genera are maintained. The following division of the British wolf spiders must be regarded as tentative:

LYCOSIDAE.

A.	Lip as broad as long, or broader; facies almost quadrate and straight on both sides.	PARDOSA.	4. *P. amentata*,[1] *agrestis*, &c.
A.	Lip longer than broad; facies usually trapezoid, sloping at the sides.		
B.	Cephalothorax high anteriorly.	LYCOSA.	21. *L. herbigrada*, *lugubris*, *agricola nigriceps*, &c.
BB.	Cephalothorax low anteriorly.		
C.	Superior spinnerettes long, with 'second joint' distinct; eyes of second row large.	PIRATA.	4. *P. piraticus*[2], *piscatoria*, &c.
CC.	Spinnerettes short and almost equal; eyes of second row not so big.	TROCHOSA.	8. *T. terricola*,[3] *ruricola*,[4] *picta*,[5] &c.

The family Pisauridae is by some authorities united to

[1] *Lycosa saccata.* [2] *L. piratica.* [3] *L. agretyca.*
[4] *L. campestris.* [5] *L. picta.*

the Lycosidae, for the differences between them are slight. It seems to be a natural phenomenon that some people possess an 'inclusive' type of mind and unhesitatingly unite genera and species where possible, while others possess a 'dividing' type and as unhesitatingly separate them. It is quite reasonable to argue that it does not matter what we do as long as we all do the same, but it is just this agreement that seems unattainable.

FIG. 27. *Pisaura mirabilis.*

The Pisauridae are represented in Britain by two species, *Dolomedes fimbriatus* and *Pisaura mirabilis*. The former, the most interesting of all our wolf spiders, is the famous raft spider of the Cambridgeshire fens. The female is a magnificent creature, nearly 25 mm. long, a strikingly marked spider of a dark brown colour with a white longitudinal mark on each side of the cephalothorax and abdomen. It has earned its name from its habit of constructing, out of a few dead leaves and some threads of silk, a small raft on which it sets sail on the face of the waters. From this raft it sallies forth over the water in pursuit of its prey, for it can run easily on the liquid surface.

Pisaura mirabilis (Fig. 27) is also a large spider, the female sometimes approaching 17 mm. in length. Its pattern varies a good deal. The better-marked specimens have a brown cephalothorax with some parallel white lines running backwards from the eyes. The abdomen is long and pointed, with yellow sides and a

dark upper surface and a sinuous dividing line between the two. Most of the pattern disappears after the female has laid her eggs.

This spider may be found in the localities usually favoured by Lycosidae, but it is rather more frequent in woods than in open fields. In spite of its great size and strength, it is not a rapid mover, in fact it stands to the Lycosidae in much the same relation as does the Clumber spaniel to the Cocker.

The female *Pisaura* is a quite exceptionally devoted mother. Her cocoon is a large cream-coloured sphere, but she carries it lovingly under her sternum and scrambles about on perpetual tiptoe until it is nearly ready to hatch. Then she climbs with it up a bush or shrub, fixes it near the end of a leafy branch, and all around and about it spins the finest set of protecting curtains, a beautiful silk nursery. Her life's ambition is now attained. She takes her stand on the outside of this product of her last labours, until, too wearied even to feed, she quietly drops out of a life whose chief care and interest has disappeared.

If it be justifiable to judge this family by one of its British representatives, then it may quite certainly be said that there is a clear difference in some essential features between Pisauridae and Lycosidae. For the present spider may quite comfortably be kept in captivity. Even in a comparatively small cage, it lives as quietly as a web-spinning species.

Although it lays down a certain amount of silk, over which its prey often trips and stumbles, it never makes any use of these threads itself. It has no need for them, for it is an extraordinarily able hunter, and hardly ever loses an insect of which it has once caught sight. Often

one sees it make a sudden dart at a fly that has walked into its range of vision, and it is extremely interesting to observe the distances up to which it is able to recognize its quarry. Four or five inches is well within its power. It is also capable of bringing down game on the wing, for I have seen a fly, buzzing along the cage at a small distance from the floor, taken in the jaws of the spider, which suddenly stood up to reach it, as prettily as a cricketer making a catch in the slips.

The spider is not easily satisfied. Although less than half the bulk of a house spider, which is well satisfied with three flies a week, it is able and willing to eat a great deal more food. Five flies a day it will tackle readily, and it will consume them entirely, so that it keeps its captor well occupied in feeding it. Altogether, it is decidedly an attractive spider.

The two genera to which these spiders belong are separable thus:

PISAURIDAE.

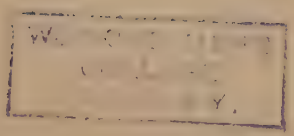
A.	Area of median eyes longer than wide; anterior median eyes smaller than laterals.	PISAURA.	1. *P. mirabilis.*[1]
BB.	Area of median eyes no longer than wide; anterior median eyes larger than laterals.	DOLOMEDES.	1. *D. fimbriatus.*

The family Oxyopidae is represented by a single and

[1] *Dolomedes mirabilis.*

very rare species in England, *Oxyopes lineatus*.[1] It is of interest chiefly by reason of its rarity and its curious gait, which is a cross between that of the Lycosidae and Salticidae. It runs along the ground, climbs stalks, and jumps from branch to branch, not taking standing jumps as Salticidae do, but running leaps. Its pattern affords it good protective coloration. It is something like that of *Pisaura mirabilis*, particularly in young examples, but the *Oxyopes* is distinguishable by a white V-shaped mark on the cephalothorax, as well as by its much smaller anterior median eyes and longer spines on its legs.

[1] *Sphasus lineatus.*



XV

CRAB SPIDERS

(THE FAMILY THOMISIDAE)

We come now for the first time to a family of spiders whose very existence is unsuspected by the average naturalist. These spiders do not, either by their habits of life or by any silken web, attract an unwelcomed attention; they are therefore easily overlooked.

Like wolf spiders, crab spiders are wanderers on the face of the earth, and not spinners of webs. They are occasionally found wandering on walls and palings, but the commonest species live in the longish grass that grows under hedges, among the drifts of dead leaves that accumulate in ditches and in similar situations. They may thus be caught by searching among the long grass, or by turning over or sifting the fallen leaves. As soon as one of them is encountered, the reason for the popular family name becomes apparent. Not only is the spider broad and low in comparison with its length, but it completes the resemblance by running sideways! The first two pairs of legs are longer and stronger than the others, and all are disposed much more in a transverse direction than in other families of spiders. Hence the spider can sidle away in the most ludicrous and unexpected manner.

These spiders adopt a third method of catching their

prey, unlike that of either web spiders or wolf spiders. It will readily be noticed by any one who comes upon a crab spider in its native haunts that its colouring tones well with its surroundings: it exhibits in fact the familiar phenomenon of protective resemblance. It puts its trust therefore neither in shaking web nor speed of foot, but in invisibility, or at least inconspicuousness. It lurks among the leaves and grass stems, and pounces unawares, sideways perchance, on the unsuspecting passer-by.

Fig. 28. *Xysticus cristatus.*

Young crab spiders are among the most enthusiastic of aeronauts, and on gossamer days they form a large proportion of the adventurous migrants. Of the rest of their habits little is known save a few isolated actions of certain species. The life of the crab spider in general provides, therefore, another large and virgin field for investigation. It should not be difficult to devise cages for them similar to those suited to wolf spiders, and the results would be bound to be of interest.

Several members of the family are common dwellers among fallen leaves and long grass, but few more so than *Xysticus cristatus* (Fig. 28), a spider which is both numerous and widely distributed. It is a fairly large species, 6 mm. long, and serves well to illustrate the typical pattern, which, with individual variations, the whole genus shows. The cephalothorax has dark sides and a pale broad band down the middle. On this pale band is a darker wedge-shaped marking, pointing backwards. The abdomen also has a broad, pale, median band, with dentated edges and a number of dark spots and other marks.

The closer relatives of this spider resemble it very strongly in pattern, and are distinguishable from it only with care.

The genus *Philodromus* and those allied to it are represented by two or three of the commoner species. They are more elongated and less squat forms than the others, obviously designed to seek their valued invisibility along stems rather than under leaves. A quite common spider in which this characteristic is developed is *Tibellus oblongus* (Fig. 29). This is a pale, narrow, straw-coloured spider, 8 mm. long, marked both on cephalothorax and abdomen with three tapering and more or less parallel brown stripes. There is, therefore, a 'longitudinal' character about the whole spider, which gives it effective concealment. One notices this in collecting. When the spider has been disturbed, and is running away, it is quite easy to follow it with the eye. Then, suddenly, it absolutely vanishes, apparently into thin air, and the closest scrutiny often fails to reveal it. What has happened is that the spider has stopped moving. The eye, not expecting this manœuvre, has travelled on for a fraction of a second, and now, when it is brought back, finds the spider invisible, or nearly so. It is a really surprising experience on its first occurrence, and nothing emphasizes better the value of this particular spider's pattern to its owner.

Another widely distributed species is *Philodromus dispar*, a spider which owes its second name to the difference between the sexes. As a general rule, the males and females of spiders have the same pattern, so that the sex of an immature specimen is indeterminable, and only in maturity can the males be distinguished

by their palpal organs and somewhat smaller size. This is not true of *Philodromus dispar*. The abdomen of the female is surrounded by a dark irregular line, enclosing a space in which is a dark brown medial band followed by a number of curved transverse marks. The

FIG. 29. *Tibellus oblongus.*

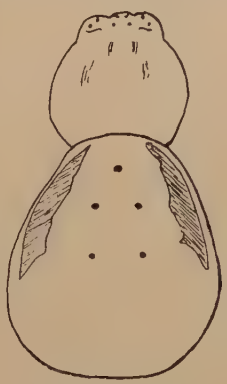


FIG. 30. *Misumena vatia.*

male is dark brown above and below, with pale edges to the cephalothorax and abdomen.

The genus *Misumena*, represented by a not uncommon species, *Misumena vatia*, illustrates a difference in habits (Fig. 30). Not all crab spiders are content to live on the ground or in its neighbourhood. Some of them climb, and conceal themselves in the leaves and flowers of trees, bushes, and small plants. Here they reap the benefit of their seclusion in the shape of a harvest of visiting insects which have overlooked them in their search for nectar.

Misumena vatia varies in colour : one may catch pale green specimens on leaves such as those of the holly

bush, pale yellow specimens in yellow flowers, and pale pink ones in pink flowers. The female lives for a long time in one place, and if it be transferred from its chosen refuge to another of a different colour, it changes its own colour, to match, in the course of a few days. The typical specimens of this spider have no abdominal pattern, but there is a variety which bears two bright crimson comma-shaped marks on the sides of the fore-end of its abdomen.

One more spider must be included in this chapter, although it is no longer a member of the family Thomisidae. Its name is *Micrommata virescens*, and it is the only British representative of the family Sparassidae. In former years this spider was included among the Thomisidae; its legs are somewhat laterigrade, but not so markedly as are those of the true crab spiders, nor some other members of its own family. It is not a very common spider, but it deserves mention because of its colour, which in the female is a lovely clear green. Thus, although it is almost without pattern, it is a very striking and beautiful spider. It is unfortunately a colour which it is impossible to preserve after death. If it were a less rare species, it would probably be called the emerald spider.

The male is even more remarkable, both in colour and because of its scarcity, being apparently much rarer than the female. It has a green cephalothorax and ground colour, but the upper side of the abdomen is a bright yellow, marked with two vivid streaks of scarlet. It is, indeed, a remarkably handsome creature, well worthy of comparison with the finest butterflies, and a great lesson for those who think of spiders as ugly and repulsive.

Compared with some other families, the British Thomisidae fall into clearly defined genera, not difficult to distinguish. The following is the table:

THOMISIDAE.

A. Cephalothorax obtuse in front, lateral eyes sessile.		
B. Posterior eyes slightly recurved.	PHILODROMUS.*	7. *P. aureolus*, *dispar*, *rufus*, *elegans*, &c.
BB. Posterior eyes strongly recurved.		
C. Cephalothorax not or slightly longer than broad.	THANATUS.*	2. *T. formicinus* and *striatus*.
CC. Cephalothorax much longer than broad.	TIBELLUS.*	2. *T. oblongus*[1] and *maritimus*.
AA. Cephalothorax truncated in front, lateral eyes on tubercles.		
B. Tubercles of lateral eyes separated.		
C. Area of median eyes narrower anteriorly than posteriorly.	DIAEA.	1. *D. dorsata*.[2]
CC. Area of median eyes parallel or broader anteriorly.		
D. Posterior eyes equidistant.	XYSTICUS.	11. *X. cristatus*,[3] *lanio*, *pini*, *sabulosus*, &c.

* In these three genera the inequality of the legs is not so marked as in the other six, and the tarsi are provided with scopulae.

[1] *Philodromus oblongus.*

[2] *Thomisus floricolens.*

[3] *Thomisus cristatus.*

DD. Posterior median eyes farther from laterals than from each other.	OXYPTILA.	9. *O. praticola*,[1] *trux*,[2] *simplex*, &c.
BB. Lateral eyes on one keel-like tubercle.		
C. Area of median eyes longer than broad.	PISTIUS.	1. *P. truncatus.*
CC. Area of median eyes broader than long.		
D. Posterior median eyes farther from each other than from laterals.	THOMISUS.	1. *T. albus.*
DD. Posterior eyes equidistant and less recurved than anterior.	MISUMENA.	1. *M. vatia.*[3]

[1] *Thomisus incertus.* [2] *Thomisus trux.* [3] *Thomisus citreus.*

XVI

JUMPING SPIDERS

(THE FAMILY SALTICIDAE)

THE spiders of this family adopt the third possible method of getting food without the use of a web. Thomisidae lie in wait for the insects they catch, Lycosidae chase them, and Salticidae stalk and spring upon them. The family is properly a tropical one, with a very large number of brightly coloured species. A more sober detachment, numbering about thirty-five in all, represents it in Great Britain.

With the exception of one cosmopolitan species, the family is not one that makes itself conspicuous. Even the arachnologist has got to look for jumping spiders carefully, and in the right places. But when they are captured they are easily recognized.

It is obvious that their method of living demands a keen eyesight, even keener than that of the wolf spiders. Therefore these spiders have very large eyes, eyes which, when compared with those of other spiders, and with the size of their owner, must remind us of Hans Andersen's dog with eyes as big as cartwheels. The largest of these eyes are those of the front row, and they stare forward with an appreciation of the view before them which is unrivalled by any other sort of spider.

A consequence of the size of the eyes is the unusual shape of the cephalothorax, which is so broad in front that the sides are almost parallel, and there is no visible distinction between the head and thoracic regions. It is this quadrangular cephalothorax that gives the Salticidae their most obvious characteristic.

It is interesting to notice the legs of these spiders, short stout limbs almost equal in length. In all other animals that jump—for example, kangaroos, jerboas, frogs and fleas, the jumping habit is associated with a marked increase in the length and strength of one pair of legs. The advantages thus gained are too obvious to need emphasis, yet jumping spiders, whose powers of leaping are greater than those of any of the above creatures except the flea, show no specialization of one pair of legs for the purpose. The question immediately arises, 'How do they jump?' This is a question which it is by no means easy to answer. Cinematography is the most likely method of solving the problem. A film, showing the activities of a jumping spider is already in existence, and if it could be 'slow-motioned' it would probably reveal the secret of a rather peculiar problem. The only published photograph of the spider in the middle of its jump, with which I am familiar, shows the spider with all its legs fully extended downwards. If this can be interpreted at all, it must mean that the spider jumps from all its legs practically simultaneously.

Salticus scenicus is the name of the jumping spider that is most commonly to be found. It is both numerous and widely distributed, and even inhabits the suburbs of London. Moreover, it is one of the few spiders with

a name, for it is well called the zebra spider. As such, it is quite unmistakable. About 6 mm. long, it has a very dark brown cephalothorax, decorated with a few white hairs. Its abdomen has a black ground colour on which lie a white crescent on the forepart, followed by two bars of white on each side (Fig. 31). The male spider is characterized by a huge pair of chelicerae, as long, sometimes, as the cephalothorax. The spider is therefore a distinct and quite a pretty little creature, one of the most attractive of all the British species, even though it would be put in the shade by some of its resplendent tropical cousins.

Fig. 31. *Salticus scenicus.*

The zebra spider hunts for food on wooden palings and brick walls, and here it may be watched at work on many days in the summer.

With curiously spasmodic hesitating movements, it runs easily over the perpendicular surface, now and again pausing to straighten its forelegs and gaze with its huge eyes round the visible horizon. Perhaps in the distance it spies a fly. It approaches that fly, until it gets within range, with movements which amount to little less than skill in stalking. Then it leaps, with an aim that is practically unerring, and deep its jaws sink in the unsuspecting victim.

I have myself seen the zebra jump in this way over distances up to 7·5 cm. As this is six and a half times the length of the spider's body, a six-foot man would have to jump nearly forty feet (and this from a standing

take-off) to achieve an equivalent result. The spider therefore performs a very creditable feat, but not one that can compare with that of the flea.

The provender which is secured by these efforts is usually devoured at once. It has been stated that if the spider is satisfied before its meal is finished, the remnants thereof are left sticking to the fence, and that the spider returns and finishes later. This may be so. I have known a zebra confine its activities to working over one not very big ceiling for four consecutive days. On the other hand, the assertion that the spider consciously returns to its 'depot' ought to be supported by proof of the exclusion of other individuals, and some sort of attempt to eliminate chance. Would the spider come back and look if the depot were removed? May it not merely see the fly if it happen to pass that way again, without any recollection of the past? To these questions my readers may discover the answers.

Further, it has been recorded that at mating-time the male spider will wrap up a fly in a silk parcel and carry it as an offering to his lady. Jumping spiders do this sort of thing; they have raised the art of courtship to a higher standard than have the spiders of any other family. Something of this we shall see presently.

There are, however, two other characteristics of jumping spiders which are more closely connected with its method of obtaining food. How can it run so securely on perpendicular surfaces? The microscope will in a moment reveal the answer. The tarsal joints of each leg are furnished with a brush of sticky hairs, called a scopula, which provides the necessary adhesiveness. Other families of spiders possess similar scopulae or

ungual tufts, but in none are they so well developed as in the Salticidae (Fig. 32).

Again, it is quite obvious that the hunting-ground of the jumping spider possesses risks of its own. The spider may miss the fly, wholly or partially, or it may miss its foothold on landing.

Fig. 32. Eyes and Foot of *Salticus*.

I have, for instance, been attracted, when sitting by an open window, by an angry buzzing which proceeded from a house-fly caught by one leg by a zebra spider. A lengthy tug-of-war followed, and must have been caused by an inaccurate jump on the part of the spider, who failed to transfix his victim. In circumstances like these a fall is more than probable, but the spider avoids the worst consequences of such an accident. All the time that it is searching the fence, it is laying behind it a silk thread, bound down at frequent intervals. Thus it provides itself with a perfect safeguard against false steps, for it cannot suffer anything worse than a moment's swaying at the rope's end. These drag-lines can be easily seen on the wall if the sun is shining on them, particularly if the light falls on the surface at a broad angle.

The courtship of these spiders is an extraordinary business, perhaps the most remarkable in the whole realm of arachnology. It has been thoroughly investi-

gated by Dr. and Mrs. Peckham in America, and their extremely able work has more than once been quoted in zoological literature: a fact which may be taken to be a well-deserved appreciation of results obtained by the most patient and painstaking work during many years.

Many male jumping spiders are enriched with vivid ornamentations, such as a brightly coloured cephalothorax or abdomen, or tufts of vivid hair on the face, or modifications in colour or form of the first pair of legs or of the palpi.

All these adornments are displayed to the female spider, before whom the male executes the most elaborate series of rhythmic movements. These dances are distinctive for each species. They include bending and raising the legs, extending the palpi, waving these limbs about and twirling them round in circles, raising and swaying the abdomen, raising the cephalothorax, and so on, through the whole series of possible movements. A single set of motions may be continued for minutes at a time, and then, if the female is unappreciative, repeated again and again.

Whatever the details of the dance of any one species may be—and descriptions of many may be read in Dr. and Mrs. Peckham's works—it is always clear that the individual movements are not chosen haphazard. It is to be noticed that the character of the dance is invariably such as displays the coloured points or structure of the male to the best possible advantage. He dances just as if he were all the time fully conscious of his charms, and determined to advertise them thoroughly before the lady of his choice. As to whether he is thus conscious is

a different problem, but the interesting fact is that, whether conscious or not, he dances as if he were.

There is a very large number of genera of Salticidae, and in the British fauna many are represented by a single species only. Many of them are rare, and even the more widely distributed ones are by no means easy to find. Moreover, they are fleeting inhabitants of their neighbourhood. It is possible to find ten or twelve individuals within an hour at a place where a week later several hours' search may be quite unrewarded. In the circumstances, the table of genera may not be of so much use as those in other chapters, but for the sake of completeness it is appended herewith.

SALTICIDAE.

A. Lower margin of chelicerae with a series of fine teeth. Sub-fam. *Pluridentati.*		
B. Sternum long, separating fourth coxae.	MYMARACHNE.	1. *M. formicaria.*[1]
BB. Sternum oval.	BALLUS.	1. *B. depressus.*[2]
AA. Lower margin of chelicerae with one large tooth, divided at the end by a rift. Sub-fam. *Fissidentati.*		
B. Anterior metatarsi with two inferior spines each, but no lateral spines.	HASARIUS.	1. *H. adansonii.*

[1] *Salticus formicarius.*

[2] *S. obscurus.*

BB. Anterior metatarsi with both inferior and lateral spines.	PANYSINUS.	1. *P. nicholsonii*
AAA. Lower margin of chelicerae with one simple tooth or toothless. Subfam. *Unidentati.*		
B. Hind margin of cephalothorax and pedicle visible from above.	SYNAGELES.	1. *S. venator.*
BB. Hind margin of cephalothorax and pedicle hidden by abdomen.		
C. Lower margin of chelicerae toothless or with one very tiny tooth.		
D. Third legs much longer than fourth legs.		
E. Ocular quadrangle parallel or narrowed posteriorly.	ÆLURILLUS.	1. *Æ. v-insignitus.*
EE. Ocular quadrangle narrowed anteriorly.	PELLENES.	1. *P. tripunctatus.*
DD. Third legs shorter than fourth.		
E. Cephalothorax long, especially thoracic portion.	PHLEGRA.	1. *P. fasciata.*
EE. Cephalothoracic proportions more normal.		
F. No spines on third and fourth legs.	NEON.	2. *N. reticulatus*[1] and *valentulus.*

[1] *S. reticulatus.*

FF. Legs with numerous spines.		
G. Cephalothorax long, sternum wide.	SITTICUS.	2. *S. caracis*, &c.
GG. Cephalothorax short, sternum narrow.	ATTULUS.	3. *A. pubescens*,[1] &c.
CC. Lower margin of cheliceriae with one strong conical tooth.		
D. Tibia + patella iii longer than tibia + patella iv.		
E. Anterior metatarsi with inferior and lateral spines.	PHILAEUS.	1. *P. chrysops*.
EE. Anterior metatarsi with inferior but without lateral spines.	EVARCHA.	2. *E. flammata* and *arctuata*.
DD. Tibia + patella iii shorter than tibia + patella iv.		
E. Small eyes of second row nearer to anterior than to posterior row.	BIANOR.	1. *B. aenescens*.
EE. Eyes of second row midway between anterior and posterior rows.		
F. Sternum very narrow anteriorly.		
G. Anterior tibiae without or with very few spines.	SALTICUS.	3. *S. senicus*, *cingulatus* and *affinatus*.

[1] *S. sparsus*.

GG. Anterior tibiae with two rows of spines.		
H. Posterior metatarsi with no spines at distal ends.	HYCTIA.	1. *H. nivoyi.*
HH. Posterior metatarsi with spines at distal ends.		
I. Sternum pointed anteriorly; first coxae nearly contiguous.	MARPESSA.	2. *M. mucosa* and *pomatia.*[1]
II. Sternum slightly narrowed; first coxae separated by width of lip.	MENEMERUS.	1. *M. melanognathus.*
FF. Sternum not narrowed anteriorly; first coxae widely separated.		
G. Posterior legs with many spines.	EVOPHRYS.	5. *E. frontalis,*[2] &c.
GG. Posterior legs without conspicuous spines.	HELIOPHANUS.	3. *H. cupreus,*[3] &c.

[1] *S. blackwalli* and *promptus.*

[2] *S. frontalis.*

[3] *S. cupreus.*

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XVII

GROUND SPIDERS

(THE FAMILIES GNAPHOSIDAE AND CLUBIONIDAE)

UNDER this name, for want of a better, are described two spider families which between them include nearly sixty species. These are the Gnaphosidae, also called Drassidae, and the Clubionidae, all spiders of an elongated cylindrical form, generally sombrely coloured and with no pattern on the abdomen. The cephalothorax is glossy, convex, and generally without grooves.

The Gnaphosidae are spiders which usually live under stones, pieces of slate, in quarries, and in similar places. They spin a small tube-like retreat which provides them with head-quarters for rest and shelter, but they generally catch their food by hunting.

One member of the family, the one which is most likely to be known to my readers, is exceptional in its habits, for it is commonly found in houses and very seldom out of doors. It is often to be seen wandering over the ceiling in the evening, and it sometimes comes to rest in our folded clothes; ready to startle us on the morrow. Sometimes it traps itself in a bath or basin, out of which it cannot climb. This species is *Scotophoeus blackwallii*. It is 8 mm. long, with a dark-brown cephalothorax and shining mouse-grey, almost greasy-looking, abdomen with no pattern.

Out of doors may be found one of the largest of British spiders, *Drassodes lapidicola*. As its name implies, it is a cave-dweller, living among stones. The female is 13 mm. in length, of a uniform dull yellow-brown, with a darker mark along the middle of the abdomen. It is a bold and fierce spider, when fully grown, and bites the fingers unhesitatingly if held in the hand.

It is not often that the name of a spider family is open to criticism or that an alternative can be seriously maintained. That this is so in the case of the present family is due to the ancient practice of establishing genera without naming a type species. Thus the generic name of *Drassus* has disappeared, being a synonym of *Drassodes*, and hence cannot give its name to the family. But those who, with Simon, retain the name Drassidae may do so because it is both long-established and perfectly comprehensible—a course which, sometimes at least, is wiser than one of academic precision.

The genera of the Gnaphosidae, or Drassidae, arrange themselves thus:

GNAPHOSIDAE.

A. Lower margin of chelicerae with keel-like blade; posterior eyes strongly procurved.	GNAPHOSA.	6. *G. lugubris*, *leporina*, &c.
AA. Lower margin of chelicerae with teeth; posterior eyes straight or recurved.		

B. Chelicerae with three teeth on upper margin and two on lower.	DRASSODES.	6. *D. lapidicola*,[1] *pubescens*, *sylvestris*[2] *minor*, &c.
BB. Lower margin of chelicerae indistinct, with one tiny tooth.		
C. Posterior row of eyes scarcely broader than interior row.	MELANOPHORA.	9. *M. pedestris*, *electa*,[3] *lutetiana*, &c.
CC. Posterior row of eyes considerably broader than anterior row.		
D. Anterior median eyes much the greatest.	SCOTOPHOEUS.	1. *S. blackwallii*.[4]
DD. Anterior median eyes not greater than the others.	PHOECEDUS.	2. *P. braccatus* and *parvus*.

The Clubionidae are close allies of the Gnaphosidae. They may be distinguished from one another by the inferior spinnerettes, which are wide apart in the Gnaphosidae, but quite close together in the Clubionidae. Also the maxillae of the Gnaphosidae have an oblique impression in the middle, an impression which the Clubionidae lack (Fig. 33).

The genus *Clubiona* includes about eighteen species, mostly yellow or brown in colour and without a pattern. *Clubiona compta* is an exception to this, for the hinder part of its abdomen is marked with a distinct pattern of transverse angular bars. This species is 5 mm. long, its

[1] *Drassus lapidicolens.*
[2] *Drassus sylvestris.*
[3] *Drassus pumilus.*
[4] *Drassus sericens.*

size distinguishing it from the similarly marked *Clubiona corticalis*, which exceeds 6 mm.

The members of this family are not often found in houses, though occasionally they 'look in, if passing'. Out of doors they do not make themselves conspicuous, and are usually to be found under the bark of trees, where they pass the winter in a silk envelope, or in situations similar to those favoured by the Gnaphosidae.

A conspicuous member of the family is *Anyphoena*

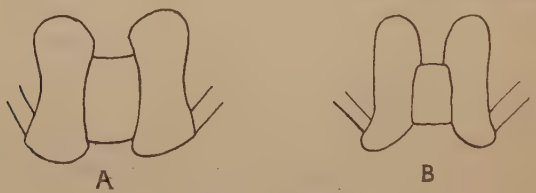


FIG. 33. Maxillae.
A, Gnaphosidae. B, Clubionidae.

accentuata. The upper surface of its abdomen is a pale yellow brown, and has near the middle two large black angular marks. Beneath, there is a transverse fold in the skin of the abdomen, concealing the spiracular orifices. The markings on the cephalothorax of this spider give it a resemblance to some of the Lycosidae, to which family it has, however, no relationship.

The same mistake may easily be made with regard to a quite common spider, *Zora spinimana*. This is a yellowish spider, 4 mm. long, with longitudinal brown bands on the cephalothorax and rows of spots on the abdomen. The posterior row of eyes is so strongly recurved that the resemblance to the Lycosidae is increased. The number of tarsal claws, two instead of three, separates it clearly from that family.

The genus *Agroeca* includes a species, *Agroeca brunnea*, which is remarkable not so much for itself as for the beautiful little cocoon which it fastens to twigs of bushes. The cocoon is like an egg, cut off sharply at the smaller end, and attached at the other end by a short foot to the stem of the shrub. After it has been finished, it is coated with a protective layer of clay.

Another member of the family is, for its colouring, well worthy of notice. This is *Micaria pulicaria*, a small species, 4 mm. long. It is adorned with remarkable scale-like hairs, which reflect an iridescent metallic sheen, of red, green, purple, and gold. The addition of several white hairs and spots makes this small creature one of the loveliest of British spiders.

The Clubionidae may be split into genera as follows:

CLUBIONIDAE.

A. Superior spinerettes with last joint distinct and conical.		
B. Lip much longer than wide.		
C. Area of median eyes wider than long.		
D. Posterior median eyes farther from laterals than from each other.	CHIRACANTHIUM.	3. *C. carnifex*,[1] *lapidicolens* and *Pennyi*.
DD. Posterior eyes equidistant and slightly procurved.	CLUBIONA.	18. *C. interjecta*, *grisea*, *pallidula*, *trivialis*, *brevipes*, &c.

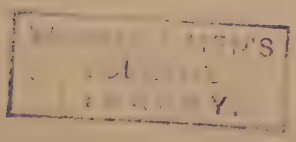
[1] *Clubiona erratica.*

CC. Area of median eyes as long as wide; posterior eyes equidistant and procurved.	ANYPHOENA.	1. *A. accentuata.*[1]
BB. Lip not, or but slightly, longer than wide; anterior tibiae and metatarsi with two rows of long inferior spines.		
C. Sternum large, produced anteriorly between coxae; anterior eyes procurved.	PHLUROLITHUS.	2. *P. festivus*[2] and *minimus.*
CC. Sternum normal, anterior eyes straight or recurved.		
D. Fourth tarsi without ungual tufts.		
E. Posterior eyes recurved.	LIOCRANUM.	1. *L. domesticum.*[3]
EE. Posterior eyes procurved.		
F. Posterior eyes equidistant.	AGROECA.	5. *A. brunnea,*[4] *proxima, inopina, striata,* and *notata.*
FF. Posterior median eyes farther from each other than from laterals.	SCOTINA.	2. *S. gracilipes*[5] and *celans.*[6]

[1] *Clubiona accentuata.*
[2] *Drassus propinquus.*
[3] *Clubiona domestica.*
[4] *Agelena brunnea.*
[5] *Agelena gracilipes.*
[6] *Agelena celans.*

DD. All tarsi with ungual tufts.	ZORA.	3. *Z. spinimana*[1] *nemoralis* and *letifera.*
AA. Superior spinnerettes with last joint very small and indistinct.		
B. Sternum bordered with chitinous rim.	CORINNA.	1. *C. praestans.*
BB. Sternum not so bordered.	MICARIA.	3. *M. fulicaria,*[2] *scintillans,* and *breviuscula.*

[1] *Hecaerge spinimana.*
[2] *Drassus micans* and *nitens* and *Schoenobates Walkeri.*



XVIII

TRAP-DOOR SPIDERS

(THE FAMILY ATYPIDAE)

TRAP-DOOR spiders, whose habits and economy are among the most interesting studies in natural history, are rare in Britain. The sub-order to which they belong, the Mygalomorphae, also called the Theraphosae or the Tetrapneumones, is composed of several families, including the Avicularíidae and the Atypidae. These two families are widely distributed over the hotter countries of the world. America is particularly rich in their members, and it is from the New World that most of the known species have been recorded.

The Avicularíidae are frequently known by the name of bird-eating spiders, and in America are invariably though erroneously referred to as tarantulas. The family includes the largest known spiders, the biggest of all, *Theraphosa leblondii*, having a body about three and a half inches long. It is not uncommon for individuals of this family to be imported into England from the West Indies in crates of bananas. Such have, on occasions, become the property of naturalists who have been able to keep them alive for a time.

The Atypidae are smaller, and the genus *Atypus* includes a few aberrant forms which are able to live in colder climates than their relatives. The two species

found in Britain belong to this genus, and are *Atypus affinis* and *A. beckii*.

The first trap-door spider's nest described is to be seen in Patrick Brown's *Civil and Natural History of Jamaica*, a work that is now almost two hundred years old. In England, the first trap-door spider was found at Hastings by Joshua Brown in 1856. It has since been recorded from Dorset and from Ventor (I.W.), and more lately colonies have been discovered by Enock on Hampstead Heath and at Woking.

Fig. 34. Chelicerae of *Atypus*.

The habits of these spiders have been imperfectly studied, for most of their activities are nocturnal and they pass the hours of sunshine below the ground in their silk-lined tubes, closed with a door that so nearly resembles its surroundings as to be invisible to any but the closest scrutiny. Thus these spiders may gain a spurious reputation for scarcity due only to the excellence of their concealment.

There are, however, a few isolated instances of fuller knowledge. Soon after Patrick Brown's discovery, Sauvage, Abbé of Montpellier, began a careful study of *Nemesia coementaria*, a trap-door spider found in that neighbourhood. The best work on European trap-door spiders was that of T. Moggeridge, who found and very fully studied a number of species living in and near Cannes and Mentone. His *Harvesting Ants and Trap-Door Spiders*, 1873, and its supplement, 1874, form one of the most delightful and most beautifully illustrated spider-books ever written. In England Enock spent several

years in careful study of the *Atypus* which he had found, and his descriptions are published in the *Transactions of the Entomological Society*, 1885.

The dwellings of the Theraphosid spiders, as we now know them, may be divided into three groups:

1. A tubular burrow, of variable form, dug in the earth and closed with a trap-door, or left open.

2. A web of close texture in the form of a carpet, terminated by a tubular retreat, like the common cobweb.

3. Any convenient hiding-place, such as the under-side of a stone, where the simplest hollow is dug and furnished with a slight web.

Moggeridge's species all fell in the first group. The hole is dug by the spider with the help of a rake-like organ on the chelicerae, and its inner walls are, apparently, hardened with a cement of dust and saliva. A silk tube then forms a lining to the burrow. The hole may be straight or branched, and it may be open, or have one door or two doors. The second door may be only a second line of defence below the first, or it may admit the spider to the branch of its burrow wherein it finds perfect concealment from an investigating enemy.

These doors are of two types. The wafer type is a thin flap of silk, a continuation, in fact, of the tube, while the cork type is a thick conical stopper, made of alternate layers of silk and earth, and fitting into the tube like a cork into a bottle. One such door Moggeridge dissected into fourteen circular patches of silk, each separated from its fellows by earth. The smallest circle was the first door made by the young spider, and as the spider grew it enlarged the burrow and consequently also the size of the door.

These structures, whose beautiful architecture has long made them an object of admiration, are, however, not made by the British *Atypus*. This spider digs a deep cylindrical burrow, usually in a well-sheltered bank. The silk lining is prolonged out of the burrow to a distance of about two inches, and either hangs loosely on the ground or stands erect among the vegetation. It has no opening, owing to the remarkable fact that the female, when once she has completed the home, never leaves it. The above-ground part of the tube is the occupant's hunting ground and corresponds to the ordinary spider's web. If an insect brushes against it, the spider within strikes at it through the silk, drags it through into the tube and down to the bottom of the burrow. It afterwards repairs the rent.

The tubes have also been found containing the remains of partly devoured worms, which had unwisely invaded the spider's domain; it therefore follows that any monotony of insect diet may occasionally be relieved by softer food.

The male spider makes a shallow nest which he leaves when mature to seek for a mate. When he comes upon a female's dwelling he serenades her by tapping with his palpi on the web. He then tears open the tube and enters.

The young are found in the nests in autumn and spring. Early in the summer they emerge through a small hole in the end, climb up some neighbouring eminence, and sail away on their little aeroplanes. Any that linger too long in setting out into the world run a risk of taking a journey of another sort down the oesophagus of their fond mother.

APPENDIX

THE COLLECTION AND PRESERVATION OF SPIDERS

THE collection of spiders, that is to say their mere accumulation as so many specimens, cannot be said to be as fascinating as some other forms of natural history pursuits. Moreover, the final product does not compare well, from an artistic point of view, with the exact rows of precisely set butterflies and similar achievements of the race well described as 'cabinet naturalists'. However, one is, or should be, brought up to believe that a collection should serve as a sort of dictionary supplying a name to any given creature, and acquainting the collector with the principles of classification. In addition, the greatest benefit to be derived from collecting is the knowledge of spiders' habits that is simultaneously acquired.

First catch your spider. The arachnologist is fortunate, probably more fortunate than any other naturalist, in that spiders can be found everywhere at all seasons. This does not mean that all times and places are equally productive, but that it is seldom that collecting is quite at a standstill.

The months of spring and early summer necessarily yield a big proportion of immature specimens, but in May and June the early summer species are maturing. By the end of June most of the mature males of these species have disappeared, so that July is the worst month for collectors. It yields a dispiriting bag of widows and orphans, and is really better devoted to cricket. In August the later species begin

to mature, and September and October are the height of the season. But spiders may be caught by sifting all through the winter.

The actual procedure in collecting is bound to be largely a matter of individual taste, and, as in all such affairs, a little experience is worth many pages of description.

Spiders are not hard to find. Their webs readily betray the presence of such as inhabit them, and the rest will be found under leaves, in ditches, by ponds, under stones and slates, in woods and in the open meadows. How are they best to be caught and conveyed?

It is always a sound plan to carry a few empty pill-boxes in which specimens may be taken home alive, in readiness to enter a cage. True it is that a pocket will not carry many boxes in comfort, and the method is undoubtedly a slow and risky one, but the collector who dumps all comers irrespectively into a bottle of alcohol is turning his back on one of the most fruitful branches of spider study. Incidentally, the habit of carrying empty boxes in the right pocket and filled ones in the left avoids many a tantalizing loss after capture. It is common experience that if a spider does escape, it is always one's best species!

Generally speaking, sweeping and beating are the most productive methods. The undergrowth is swept with a large stout net, and the accumulated rubbish turned out on to a sheet of newspaper, canvas, or, best of all, white mackintosh. The spiders that walk out are covered with a small glass tube, up which they will run, when they can be shaken into a bottle containing 70 per cent. alcohol. Small spiders may be quickly and easily picked up with a moistened forefinger.

It is quickly realized that running and jumping spiders, even those with a fair turn of speed, are more easily entrapped than web spiders. Webs are often spun on bushes, and at an incautious approach, the spider drops into the middle and

finds sanctuary from anything short of a bonfire. The web spider dislodged and dragged into the open is, however, easily taken, and multitudes may be caught by beating and shaking bushes, hedges, and trees over an inverted umbrella.

Sifting, too, yields numbers of species. Drifts of dead leaves or pine needles or such material are shaken in a sieve over the newspaper or cloth. Grass roots may be cut with a strong knife, including some of the earth, and treated in the same way with good results. This is the method to use all the winter.

The only way to preserve spiders is in diluted alcohol, preferably 70 per cent., the spirit contained in specimen tubes about 2 in. × ½ in. or smaller. The brilliant colours may disappear, in fact the green of *Epeira cucurbitina* and *Micrommata virescens* cannot be preserved by any method known to me, but the spider is readily available for examination, and no further changes will occur if the spirit does not evaporate. Some books advise preserving spiders in turpentine. Avoid this; it makes the creature too brittle to examine without fear of breakage, and the same is true of undiluted methylated spirit.

The spirit, however, always does evaporate at a rate depending on the efficiency of the various corks, many of which, as commonly supplied in such tubes, are almost worthless. The best way to counteract evaporation is to group the tubes in wide-mouthed ground-stoppered bottles, in which the maximum vapour pressure of spirit[1] is soon reached. According to the size of the collection, each one of these bottles will be limited to a family, a genus, or a species. The ideal collection consists of a bottle to each species, and each contained tube records the date and locality of the specimens within it.

This adds considerably to the expense, an addition which

[1] The spirit will also go brown, with large spiders, after a day or two, and should be changed until this no longer occurs.

may be reduced by using fruit-preserving jars or air-tight tins. Glaxo tins make a most admirable and efficient substitute. The methods also necessitates careful double-cataloguing of the tubes, if any species is to be traceable at once.

Such a catalogue is the most convenient way of keeping the record. Alternatively, the name of the spider may be written in Indian ink on parchment-paper and placed in the tube, but it is easier to write a number on the cork. It is better to write on the cork than on a label, as labels will never remain certainly fixed in a spirituous atmosphere.

If the spider in its tube is required for exhibition only and does not need to be removable, another method may be used. The tube is rather more than half filled with a paste of plaster of Paris and water and allowed to set in an horizontal position. The flat face of the plaster semi-cylinder is then smoothed and the spider fixed to it with insect cement. The whole is then immersed in strong spirit in the tube, corked up, and evaporation prevented by dipping the cork and top of the tube in molten paraffin wax. Carefully carried out, this method yields permanent results.

About a hundred species of spiders can be found in most neighbourhoods with ordinary care in a single season. They correspond to the first five hundred stamps in the schoolboy's collection. Thereafter more and more intensive collecting is necessary as the rarity increases.

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THE first part of this bibliography is an almost complete list of books on spiders published in Europe and America, with notes on the most important. The second part consists of references to a few papers which are usually easily accessible and are of general interest. For others, the reader is referred to the Zoological Record, section Arachnida.

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GLOSSARY

Amoeboid, capable of moving, like Amoeba, by changing shape.
Capillaries, the smallest blood-vessels.
Cephalothorax, the fore part of a spider, the head and thorax together.
Chelate, pincer-like, as the claw of a lobster.
Chitin, a nitrogenous compound of which the hard parts of many invertebrates are made.
Clypeus, part of cephalothorax between eyes and base of chelicerae.
Coelom, the body cavity, between gut and body-wall in vertebrates.
Colulus, small conical appendage between the inferior spinnerettes.
Corpuscle, certain small cells, such as blood corpuscles.
Diffusion, the passage of a gas or a dissolved substance through a porous membrane.
Diverticulum, a blindly-ending branching passage.
Ecdysis, casting of the outer skin, 'moulting'.
Epigastric furrow, the fold behind the reproductive portion of the abdomen.
Epigyne, the external genitalia of the female spider.
Exoskeleton, the supporting, protecting structures outside the body.
Facet, a little face, a small element of surface.
Follicle, a sac-like membrane, containing, e. g., an ovum.
Fovea, a groove or furrow.
Ganglion, an aggregation of nerve-cells.
Haemocoel, the spaces within the heart and blood-vessels.
Homology, essential structural identity due to community of descent.
Invaginate, to push in an outer surface so that it forms the inside of a hollow.
Labium, lower lip or surface of mouth.
Lymph, the fluid constituent of the blood.

Malpighian tubules, the excretory organs of arthropoda.
Mandible, the chelicerae or falces of the spider.
Maxilla, in a spider, the basal joint of the palp.
Ocelli, simple forms of eyes.
Ostia, orifices of the heart or pericardium.
Pectinated, having teeth like a comb.
Pedicle, the delicate waist joining cephalothorax and abdomen.
Pericardium, the bag enclosing the heart.
Phylum, the biggest division in classifying the animal kingdom.
Procurved, curved with the convexity backwards.
Recurved, curved with the convexity forwards.
Rostrum, in a spider, the upper surface of the mouth.
Sclerite, a small plate.
Scopula, brush of hairs at the end of the tarsus.
Sinus, a wide space.
Spiracle, a respiratory aperture, the orifice of a tracheal tube.
Trachea, a tube conveying air within the body.
Unchelate, not pincer-like, having only one blade or point.
Vas deferens, duct from testis to exterior.

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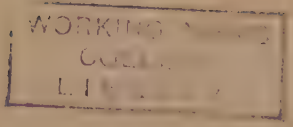
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